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NATURAL HISTORY

THE MAGAZINE OF
THE AMERICAN MUSEUM OF NATURAL HISTORY

VOLUME LXXII
1963

Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
NEW YORK, N. Y.

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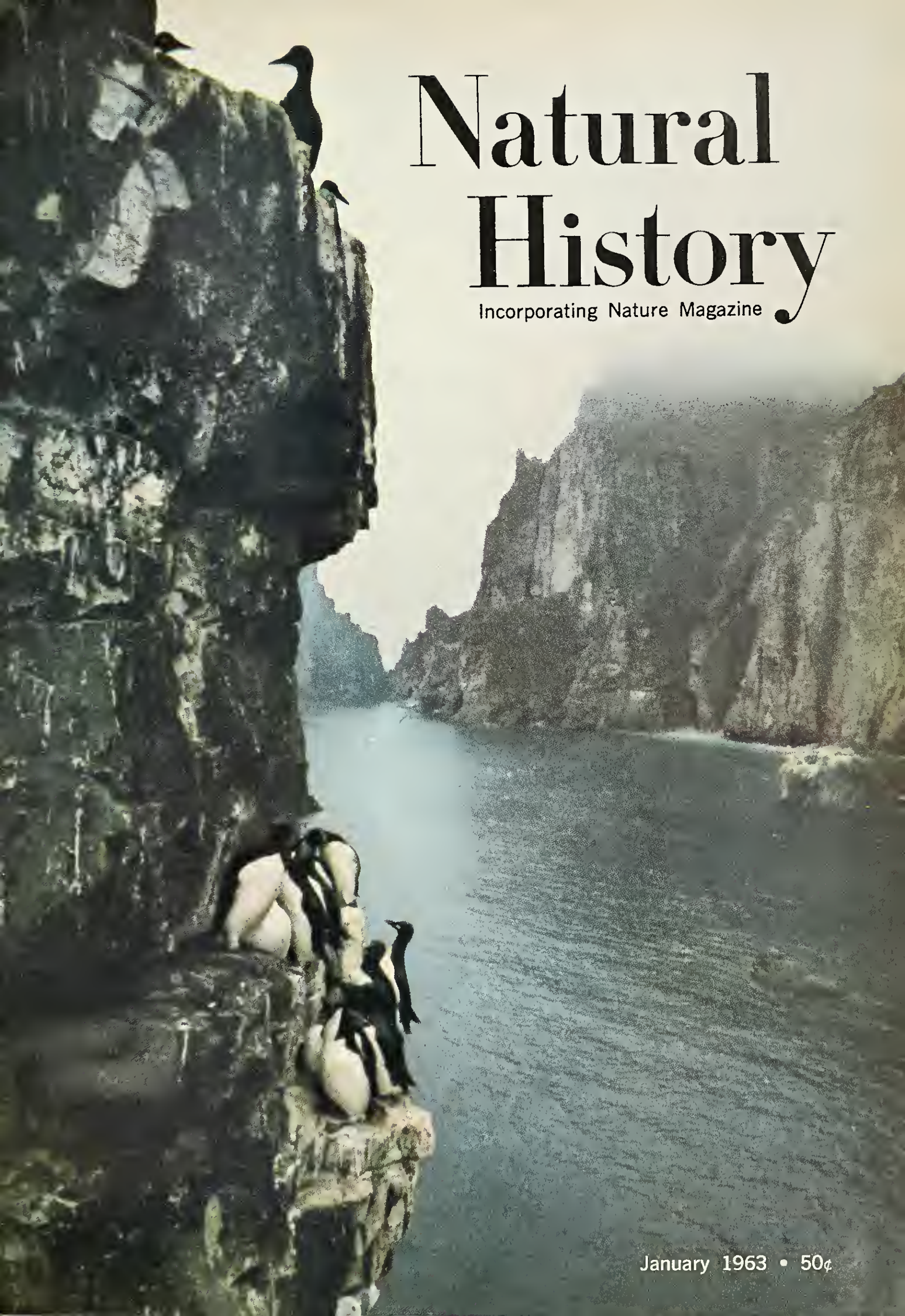

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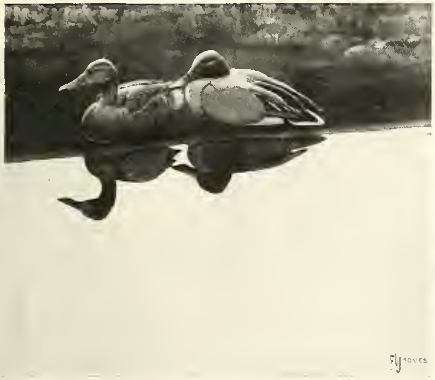

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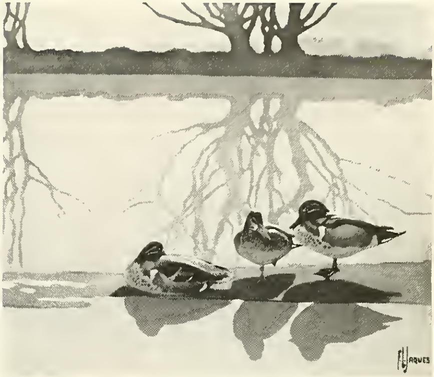

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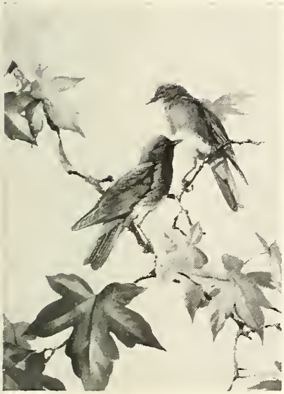

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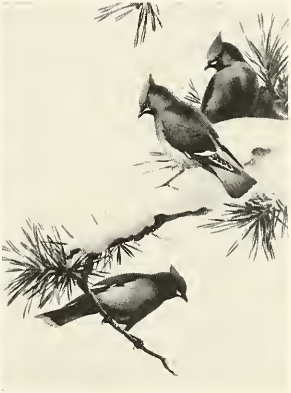

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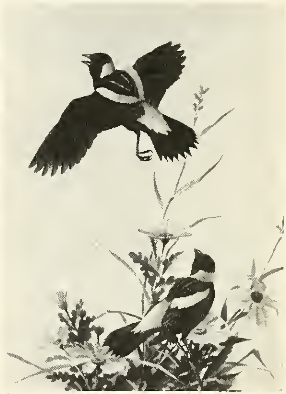

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Vol. LXXII JANUARY 1963 No. 1

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COVER: The birds perched precariously on rocks that tower high above the Barents Sea are murres, members of the auk family. Six species of these fish-eating birds share the crags of Bear Island, living in dense, noisy colonies and laying their eggs on the bare rock. The thick-billed murres, distinguished from the common murres by a white line at the base of the upper mandible, seem to prefer very narrow ledges, while the common murres usually nest on slightly wider shelves. More about murres can be found on page 26. All photographs are by Fred Baldwin, who has spent much time in the Arctic.

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York 24, N. Y. Published monthly, October through May, bimonthly June to September. Subscription Price: $5.00 a year. In Canada, and all other countries: $5.50 a year. Single copies, $.50. Second class postage paid at New York, N. Y., and at additional offices. Copyright, 1963, by The American Museum of Natural History. No part of this periodical may be reproduced without the written consent of NATURAL HISTORY. The title NATURE MAGAZINE, registered U.S. Patent Office. Unsolicited manuscripts and illustrations submitted to the editorial office will be handled with all possible care, but we cannot assume responsibility for their safety. The opinions expressed by authors are their own and do not necessarily reflect The American Museum's policy.

Reviews

On man the destroyer

By William Vogt

Silent Spring, by Rachel Carson. *Houghton Mifflin Co., $5.00; 367 pp., illus.* Our Synthetic Environment, by Lewis Herber. *Alfred A. Knopf, $4.95; 285 pp.*

The rumpus raised by Miss Carson's book has largely disregarded the most important aspect of its message—the same as in Mr. Herber's volume—that man is still as much a part of nature as, more than a century ago, Darwin showed him to be. He boasts of his adaptability when, in fact, he is probably less adaptable than the cockroach. It is his environment that is "adapted," and man remains a mass of protoplasm that lives and dies by the same chemical processes that govern the molecular behavior of other creatures. "All flesh is grass" is as true today as in the time of Isaiah.

Man has done many wondrous things and, alas, many foolish ones. He has fouled not his own nest but his entire environment—the air he breathes, the water he drinks, the soil that produces his food, the very food itself. He has reduced almost infinitely varied nature to the uniformity of pure stands of food and fiber that are even more ideally suited to his insect enemies than to himself. By abuse of environment he has, over thousands of square miles, improved the habitat of rodent competitors and then tried to exterminate them with poison. He has spread the sterility of deserts in the tropics and subtropics from Mexico, through the Middle East, to India. He has destroyed more beauty than will ever be accumulated in all his galleries. Perhaps his major stupidity has been, to paraphrase Mr. Herber, to give the most pernicious laws of the market place precedence over the most compelling laws of biology.

Man has created, in his cities, ideal situations for certain diseases. It is, surely, only semantic inhibition that keeps us from labeling "epidemic" the cancers that kill more than a quarter-million Americans a year and the mental illnesses that fill half our hospital beds and condemn thousands more to lives that are barely tolerable.

It is man's mismanagement of his environment that is the theme of both these books. Their documentation of this mismanagement gives them major importance. They are far from saying the last word, but they say some of the first things that should be said and say them well.

Miss Carson concerns herself primarily with the effects of the millions of pounds of insecticides and herbicides that man has been scattering, often with wild recklessness, across the landscape. She has been accused of being "one-sided," as though this were a fault. I have never heard St. Paul criticized for not giving Satan his due, though he is obviously a devilishly engaging fellow.

Mr. Herber ranges far more widely than Miss Carson and discusses not only herbicides and insecticides, but also nutrition, chemical fertilizers (he is no organic gardener), soil structure, food additives, stresses that result from over-urbanization, our physical deterioration from excessive dependence on machines, and other side effects of civilization.

Both authors approach their subjects from a basically ecological point of view though neither, as will be discussed, follows through to completely logical—or ecological—conclusions.

The publication in *The New Yorker* of about a third of Miss Carson's brilliantly written text makes it impossible to give her the silent treatment accorded Mr. Herber, whose book was published three months before hers, and it is to be hoped that he may now ride into the limelight on her coattails.

The justice of the accusations in these two books will, to a considerable extent, be established by the behavior of the defendants: will their answer be a thorough house cleaning or will it be an attempt to discredit the charges by self-serving attack? *Silent Spring* could do for the control of chemical pollution of our environment what Upton Sinclair's *The Jungle* did for the Pure Food and Drug Act in 1906.

Miss Carson is, alas, all too vulnerable to attack because of a tendency to exaggerate and an occasional, uncritical acceptance of data. "Every human being," she tells us, " is now subjected to contact with dangerous chemicals from the moment of conception until death."

Dr. Vogt, an internationally known, award-winning scientist, specializes in both the behavior and the ecology of birds, in human ecology, and in the conservation of our natural resources.

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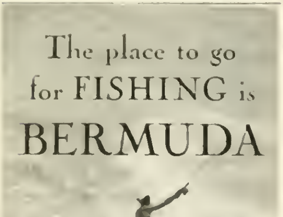

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Her statistics are sometimes regrettably inconclusive. "Samples of body fat collected from the general population between 1954 and 1956," she tells us, "averaged from 5.3 to 7.4 parts per million of DDT . . . such items [in prison food] as stewed fruit containing 69.6 parts per million and bread containing 100.9 parts per million of DDT!" Miss Carson does not tell us the size of the samples, how and where they were gathered, nor give any indication, such as their standard deviation, by which we can evaluate the "averages." If one has had even a little experience with statistical sampling the lack of such data leads one at least to withhold judgment on their meaning. This is not as good evidence as the trout in Thoreau's milk.

Many of her thoroughly researched citations, totaling fifty-odd pages, are unidentifiable because in her bibliographic appendix she, unlike Mr. Herber, refers only to pages and not to lines.

She quotes a statement implying that the dog tick (she gives no scientific names) has increased in the New York City region because of growing resistance to insecticides. Naturalists in our area have seen many alterations in animal numbers over the past three or four decades. The cardinal, opossum, and certain southern fishes have greatly grown in numbers. Their increase certainly has nothing to do with pesticides. What evidence is there that the tick has not increased for exactly the same reasons as have other animals?

She quotes a paper by Dr. Joseph J. Hickey, of the University of Wisconsin, on heavy robin mortality—86 to 88 per cent—as a result of spraying, but does not cite Hickey's observation, in another paper, that when such killing is concentrated and large populations of birds live outside the sprayed areas, they will repopulate empty habitats once the toxicants disappear, sometimes in a matter of weeks. Comparable recovery in trout food populations is reported by the Conservation Foundation after spruce budworm spraying in Maine.

It is distasteful, for an admirer of Miss Carson and her writings, to have to point out these shortcomings, but one can more effectively praise her after admitting her defects.

That both she and Mr. Herber have written powerful indictments of those who would short-circuit ecological processes is incontestable. The fact that arsenicals, chlorinated hydrocarbons, and organic phosphates are dangerous is clearly indicated by the theoretical "tolerances" that both government and manufacturers have set—often to reduce the limits later or even to remove the chemicals from the market. No control has been established over their possible genetic damage.

That they have been broadcast over millions of acres, without prior consent of those owning or living on the land, is a matter of record. Even national parks are not immune—which should call for some explanations from Washington.

That they have at times failed of their purpose is demonstrated not only by reports of competent scientists, but also by the way the U. S. Department of Agriculture, after repeatedly poisoning vast tracts in the name of fire ant and gypsy moth "eradication," has tapered off the spraying campaigns though the insects they were aimed at still remain.

That these wholesale poisonings have caused agonizing deaths to very large numbers of non-human living creatures is undeniable. Miss Carson's doubt of our moral right to such slaughter would have high value in a Buddhist society. Christians are likely to give it short shrift if the poisoning effectively increases profits or comfort. The humane societies have been conspicuously inactive, as they usually are when their popularity might be jeopardized.

That the chemists and entomologists didn't know their gun was loaded is made clear by reports from both authors of situations that were far worse after the use of chemicals than before. The development of DDT-resistant strains of house flies and mosquitoes is well known; malarialogists in many parts of the world are being harassed by the remarkable genetic adaptability of *Anopheles*.

Some of the other damage to environments we share with other forms of life may show results more slowly. Both authors discuss a subject that is widely ignored and about which we actually know very little: the ecology of the soil. Miss Carson's chapter on this is superb.

Her reports of the effect of new chemicals on cell physiology, with possible genetic and carcinogenic results, are fascinating and hair-raising—as well as speculative and suppositititious. But she and Mr. Herber, citing respected scientists, plow deep furrows in which to sow their seeds of doubt.

Both authors raise issues in such a way that they can scarcely be ignored, particularly by technicians of the regulatory bodies. They (especially Mr. Herber) are sharply critical of the Food and Drug Administration, which has long—with justification—pleaded lack of funds and staff; Miss Carson castigates the U. S. Department of Agriculture for what can only be called irresponsible broadcasting of poisons. The U. S. Public Health

Service, which for decades has dragged its feet on water pollution, gets off too easily. Neither writer points out that the Secretary of Agriculture is *directed*, by laws passed before the development of the new and diabolic poisons, to "control" and "eradicate" insect pests—which throws the problem right back into the lap of the Congress. Or, to put it another way, to you and to me.

Neither author quite achieves an ecological approach by viewing these problems as a dynamic structure of dependent variables in which our economy is embedded. Could we feed 186 million "guinea pigs" without these poisons (our pestiferous "surpluses" amount to only about 5 per cent) and shall we be able to feed 350 million in the year 1999? What part do such substances play in trying to feed three billion world-wide, adding about another billion each decade? What would the control or abolition of such materials, on our approximately four million farms, do to their capital and labor input, to their social structure, and to the cost and availability of food? Both authors suggest possible alternatives, but these are not, on the whole, practices that would be feasible until after years, or even decades, of experimentation and adjustment.

Certainly, without chemical aids our vaunted farm-production-per-man-hour would drop sharply, and it is dubious whether we could maintain production-per-acre at anything like current levels. The high-producing countries of the pre-chemical era—Denmark, Holland, and Japan—depended heavily on natural manures with relatively low-production-per-man-hour.

If Miss Carson and Mr. Herber are substantially correct in their facts and interpretations, and I believe that on the whole they are, a return to health and sanity will probably be roughly as complex and difficult as would have been the establishment of control over numbers and use of automobiles forty years ago. It might conceivably have been possible, before our society had become so thoroughly motor-dependent, to prevent the future hypertrophy and constipation of our metropolitan areas, the poisoning of their air, the repeated decimation of our wildlife, and the killing and maiming of far more Americans than have yet felt the icy hand of cumulative poisons. Will we move fast enough, now, to escape possible immolation in the metabolic by-products of a technology gone wild?

Both books end on somewhat hopeful notes, as is all but required by American convention, but to this reviewer it seems like whistling in the dark. If we do escape, our debt to Miss Carson and Mr. Herber will be substantial.

Silent Spring has been decorated with elegance by Lois and Louis Darling.

These books cannot be adequately discussed in such limited space. But I should like to urge every reader: if you have time for but two books next year, read these; if only one, read one of them.

Primitive Song, by C. M. Bowra. *World Publishing Co., $6.50; 303 pp., illus.*

It probably takes a poet to throw academic caution and procedure to the winds, in an academic study, and get away with it. Sir Maurice Bowra, for five years Professor of Poetry at Oxford, and then Vice-Chancellor of that university, is both a poet and a scholar, and his latest and absorbing work, *Primitive Song*, is at once flagrantly disrespectful of academic niceties, and a highly stimulating, refreshing work of scholarship.

On the first page of the preface he boldly states: "I am not an anthropologist, and, though I have long been interested in the study of language and languages, I know next to nothing of those with which I deal here." His sources are limited, and vary from the most reliable and respectable to the most unreliable and dubious. Bowra treats hearsay with as much care as he does the clear, impeccable, factual information of scholars such as Schapera—no more, no less. Perhaps it is his poetic intuition that enables him to perceive the broad truths that

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underlie all his material, for this is what he does in a masterful way in this volume, going far beyond the original stated objective of the book.

His objective is to establish "illuminating conclusions" about the earliest types of literature. Such literature of course no longer exists, never having been committed to writing; even the oral tradition has been lost in the remote past. His method is to make a comparative study of the poetry of "the most primitive peoples still surviving in the world," and the "most primitive" are those who still live by hunting and gathering. So far so good, but now comes the first methodological blunder. The comparative method is fine so long as the material is comparable, but in much the same way that the eminent Oxford anthropologist Radcliffe Brown generalized about the structure of human society from a somewhat secondhand and limited knowledge of the Andaman Islanders, Australian Aborigines, and American Indians, so does Bowra generalize about ancient primitive man from the living Eskimos, Aborigines, and African Pygmies. However, just as Radcliffe Brown produced a few untenable theories but provided a stimulus that set British social anthropology off on its truly academic career, so does Bowra succeed in providing a stimulus that should make anthropologists, among others, aware of a vital field of information still waiting to be reaped. Bowra ends with conclusions about early literature and about primitive man himself, and the place of poetry, song, music, and dance in his life.

The first part of the book, however, keeps to his original subject. He opens by discussing hunters and gatherers in general, though in all fairness it must be said that if his over-all picture is of an unjustifiably generalized "hunter and gatherer," the author is always meticulously careful to keep the particular in sight, quoting the group providing that specific information. Much of the information is doubtful (such as his assumption that the "smaller race" discovered by the Nasamonians from Libya, quoted by Herodotus, are necessarily Pygmies), and some is downright false (such as the statement that when the Pygmies were first discovered "these poor savages had no means to protect themselves against greedy, unscrupulous, and self-righteous invaders . . . and were mercilessly destroyed.") He preserves a number of popular myths, like "silent barter" between Pygmies and Bantu, and he seems to agree with Hobbes that the life of primitive man is "solitary . . . nasty, brutish, and short."

Apart from his general picture of hunters and gatherers, Bowra defines custom as the embodiment of accumulated experience and gives some useful pointers on its relationship to song as an expression of primitive man's thoughts and feelings, as well as its possibly dangerous relationship with his social life. He also suggests that although custom has prevented much outward change in his simple methods of food-getting, modern primitive man differs from his Paleolithic forebears by his movement toward an inner complexity. And through his song, Bowra says, we can see primitive man as he really is, "and not through the distorted vision of murderous enemies or misguided well-wishers." In other words, the author is not only interested in song, but in the man who makes it—and the most pleasing characteristic of the entire, finely written book is perhaps this dual exploration.

Following the general introduction Professor Bowra launches into an analysis of composition and performance, technique, and manner and method. But each chapter is full of allusions to primitive life in general: the aspirations, joys, and fears of primitive man. While recognizing that primitive song is not complete when it is divorced from music and movement, Bowra says that it can still take us into "the consciousness of primitive man at its most excited or exalted or concentrated moments, and (it throws) a light, which almost nothing else does, on the movements of his mind." Here, as an anthropologist who has worked with song among hunters and gatherers, I would enjoin caution, for the words of songs are not only often trivial—they are often deliberately misleading, and cannot be correctly interpreted without a detailed knowledge of the people and their total society.

In the last chapters, on primitive imagination, myth, and symbol, and in his conclusions, Bowra attempts, through his understanding of song, a reconciliation of the world of make-believe with the world of reality, and if the examples he quotes are taken as a series of ecstatic vignettes they serve an admirable purpose. However, because he uses them to draw conclusions that are too general to be valid he opens himself to criticism. ". . . in the moment of loss (primitive peoples) find no consolation in the thought of life beyond the grave. . . . Their reactions to it are violent, disturbed, and distressed." The Pygmies, however, who are important to Bowra's argument, certainly do not think of life as being "fragile," "precarious," and "uncertain." To them, on the contrary, it is powerful, abundant, and definite. The same Pygmies, for whom the world is rich and good and kind, and to whom death comes, with regret and grief, but as naturally as life itself, would probably howl with laughter at the conclusion

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Bowra draws from a single song sung by the Pygmies of the Gabon: "The despair which sounds in some of these songs is all the more poignant because it reflects some vaster catastrophe in which primitive men believe themselves to be doomed to extinction. . . . Such is the dark background against which primitive life is passed."

Having seen a whole hunting band of Pygmies sing and dance for joy every night for over a month, for joy that an old lady, the "mother" of them all, had "died well" having lived a full and happy life, I am afraid that this particular conclusion makes me suspect that there must be some "dark background" in Bowra's own life that leads him to take such a dismal attitude toward his fellow poets in remoter parts of the world.

But *Primitive Song* does not demand that the reader accept its conclusions, for Bowra *is* a poet. Whatever he writes stirs the imagination to the possibilities of wider experience and even greater truths than those expressed in words. Above all it shows how song enables our less complex fellows "to absorb experience with their whole natures and thereby to fulfill a want which is fully satisfied neither by action nor by thought."

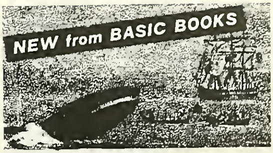
COLIN M. TURNBULL

THE SENSES OF ANIMALS AND MEN, by Lorus and Margery Milne. *Atheneum Publishers, $6.95; 305 pp., illus.*

MAN has been put in his place by the Milnes. In the book, *The Senses of Animals and Men*, they compare man's capabilities in sensing his environment with those of other animals. Man, in many instances, comes out second best, and after reading about the ways in which bats and porpoises echolocate, fish use electrical fields for detecting prey, insects respond to the vibrations of other insects, and animals detect the minutest changes in temperature, to name a few examples, he may be forced into a feeling of inadequacy. He may also begin to give some thought to the changes going on in his immediate environment — changes about which he can never be totally aware.

The book is a collection of the works of many scientists who are studying sensory systems, biological clocks, navigation, migration, and related subjects. It is divided into twenty-one chapters, and each one deals with a different sensory mechanism, or with some aspect of animal behavior. The research described is recent, and is accurately reported in a typically readable Milnean style. There are references for each chapter, there is a good index, and Kenneth Gosner's illustrations are fine.

Nevertheless, I have several objections to the book. First, it contains far too much information about too many animals. The general reader, for whom it is



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intended, will be overwhelmed by the sheer quantity of fascinating information. He would do well not to attempt to read the entire book at one sitting, but rather to concentrate on one section at a time. Second, I object to the broad use of the word "sense." It would have been better to have kept to sensory mechanisms as such, rather than to delve into a different use of the word, as a *sense* of security—a usage that here tends to confuse rather than to clarify. Third, there were innuendoes that I found irksome, particularly the assumption that many animals seek certain comforts with advance knowledge that they will be comfortable. Fourth, I object to mixing fact with theory. I know that many science writers abhor the words "maybe," "possibly," "perhaps," and similar qualifiers. Notwithstanding the arguments in favor of positive statements, I think it is important for the reader to realize that science is only beginning to know, and that for every question answered, ten more are posed.

Despite these drawbacks, the book should provide stimulation for the general reader with a biological background, and for the advanced high school or early college student who has observed animals in the field.

EVELYN SHAW

BEYOND YOUR DOORSTEP, by Hal Borland. *Alfred A. Knopf, $5.95; 401 pp.*

WITH good humor, the modesty of true wisdom, and the knowledge gained both from books and from long personal experience, Hal Borland writes of the natural scene as he views it from his hundred acre property on the banks of Connecticut's Housatonic River.

His book is, however, more than a mere recording. It is a sort of primer, a how-to-observe-nature-yourself volume, which becomes dull only when the author descends from the high plane of personal experience and observation to mere condensation of biological field books and facts. But, as the author points out, his book is intended to be useful rather than authoritative, so such an approach is both pardonable and helpful.

What Mr. Borland really enjoys, and what he wants his readers to enjoy along with him, is the face of nature and the bone and tissue that form it. He is not a professional biologist, does not pretend to be, and does not suggest that the reader become one. But he does say that close observation of nature increases one's enjoyment of it and, practicing what he preaches, he carries in his pocket a magnifying glass, which makes visible to him (and could to you) the Lilliputian world of plant and animal life that is invisible and unknown to most amateurs. Mr. Borland applies his glass to a head of white clover growing

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in his backyard, and finds that: "The petals are clear, creamy white, and beautifully curved. Staring through the glass, you seem to hold an exotic corsage in your hands."

In essence, Mr. Borland's book is a treatise on how to make corsages out of clover; how to get the most enjoyment out of our natural world. It is an eminently practical book, in which can be found information about bats in your attic, wasps in the closet, etc. But its main contribution transcends mere practicality—it is a philosophical approach to our relations with the natural world.

Mr. Borland is at his best as he drifts down the Housatonic River of a quiet summer evening, presumably fishing, but not caring whether or not he catches anything. The fishing is merely an excuse to watch and listen. This is a book for anyone who has seen nature from the butt end of a fly rod, from the view of a bird-feeder, or from a solitary walk in a pine-needled woodland.

PIETER FOSBURGH

MAMMALS OF WISCONSIN, by Hartley H. T. Jackson. *University of Wisconsin Press, $12.00; 504 pp., illus.*

THE literature of mammal studies in North America has taken several primary forms: technical articles of more or less limited scope; large-scale revisionary works; field books or guides of general interest; and faunal reports, which usually concern a local area or an entire state. The most useful works to the lay naturalist are the field guides and the state lists, with the latter being consulted for more detailed information than the general guides provide. The organization and content of state lists varies greatly. Some, such as *The Recent Mammals of Arizona*, by E. Lendell Cockrum, published in 1960 by the University of Arizona Press, provide only a basic framework of information, such as keys for identification of species, recognized scientific names, synonyms, and known distribution. Hartley Jackson's *Mammals of Wisconsin* includes this same basic data, as well as additional information on common names, habitat, population density, breeding, foods, predators, and the economic importance of the 72 known species of wild mammals from Wisconsin. Much of this information is compiled from published studies in states other than Wisconsin; these sources are usually cited. Such detailed accounts make the book useful to persons with a general interest in the natural history of areas outside the state of Wisconsin alone. The book is amply and beautifully illustrated with photographs, maps, and line drawings of study skins, skulls, burrows, droppings, tracks, and other features.

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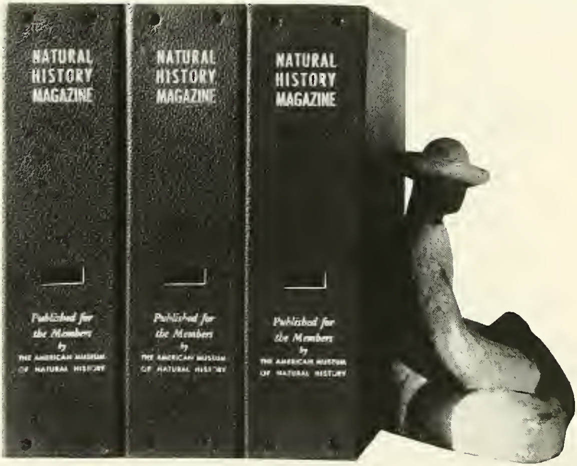
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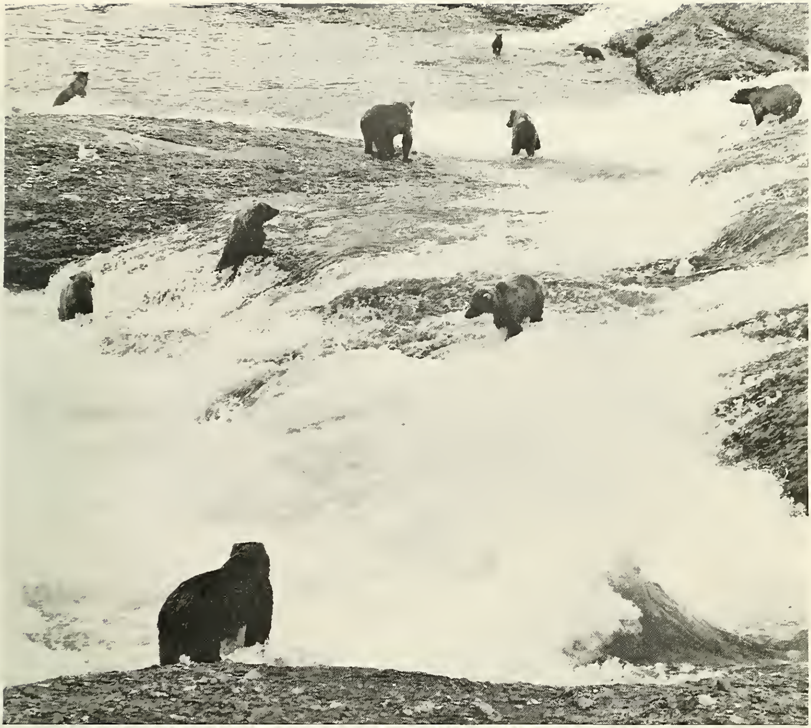


Brown bears customarily seize fish with their teeth, as at left, although some reports say they use their paws.

When salmon run in July and August, bears gather at the streams in loose groups, but are solitary for most of year.

Solitary Carnivore

North American brown bear behavior alters during salmon runs

By Milton B. Trautman

Of all the flesh-eating land mammals on earth, the big, or giant, brown bear *(Ursus middendorffi)* is reputedly the largest. A huge male, or boar, weighs in the neighborhood of 1,500 pounds. Its combined head and body length may be 8 feet; its height at the shoulders $4\frac{1}{2}$ feet.

Not all brown bears are giants, of course, for there is much variation in size—individually in the same area and among bears from different localities. These variations appear to be chiefly the result of the kind and abundance of the food supply. The largest bears usually are found on Kodiak Island and the coastal area of the adjacent Alaska Peninsula. There, when they leave their winter quarters in early spring, they find considerable carrion—in the form of dead fishes, sea birds, an occasional seal, walrus, or whale—and quantities of kelp and other aquatic vegetation. In late spring there is an abundance of many species of vascular plants, sedges, and grasses, and, like cattle, the huge beasts are avid eaters of vegetation. Then, in July and August, there is a plethora of fat-producing, protein food in the form of five species of salmon. These are either captured as they ascend streams on their spawning runs, or later when, having spawned, they are dead or dying. In addition, there are usually many blueberries, bearberries, crow-

FEMALE BEAR, or sow, spends much time playing with her offspring. She always stays close to it, providing its food and protecting it from other adults.

berries, elderberries, and a variety of other fruit. When they enter their dens to winter over, bears from such favored localities are not only large but they are also excessively fat.

Their fellows in more inland localities or on other islands do not fare so well, presumably because of a lack of an abundant supply of vegetable and animal food at critical periods. Some of these bears live almost exclusively upon vegetation and usually weigh much less than 1,000 pounds when they are fully grown.

TAXONOMISTS differ widely in their classifications of the brown and grizzly (*Ursus horribilis*) bears. Some believe that the two are conspecific, differing only subspecifically; others believe that there are several species and/or subspecies of each. The name "brown bear" is something of a misnomer, for although there are bears of this species whose fur is indeed brown, others range in color from a light yellowish gray to bluish black. There is possibly some correlation between color of fur and amounts of rainfall, fog, and cloud cover. Bears with the lightest fur predominate in areas — usually inland — where annual rainfall is light and the percentage of fog and cloud cover is low. Those with the darkest fur inhabit coastal areas, where the annual rainfall may exceed 150 inches and where fog and heavy cloud cover predominate.

The range of brown bears in North America is limited. It extends only from the northern coast of British Columbia up along the Alaskan coast and adjacent islands, including Kodiak, to the northern shores of the Alaska Peninsula.

This bear is normally solitary, especially in spring and early summer, when individuals are scattered widely over the mountains, valleys, and seacoasts. At this period of the year only mating individuals and mother bears (sows) with their cubs are in close proximity. But during July and August, when the vast hordes of salmon enter the coastal streams and migrate toward their spawning grounds, the majority of the bears desert the mountains and valleys for these streams. At this time they are inclined to assemble in loose groups beside the falls and rapids where salmon are easy prey. Even then, however, they usually do not approach within paw-striking distance of each other, and under virtually all conditions smaller individuals assiduously avoid larger ones—particularly old males—when food is scarce. If a large, hungry bear catches a smaller one it may kill and eat it, and a sow must constantly protect her cubs. Sometimes the sow leaves her cubs on the bank when she enters swift, deep water to capture salmon, but even then keeps an eye on them.

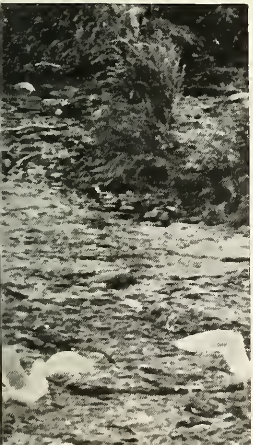
The young of few animals are more playful than are these cubs in their

Two CUBS watch as their mother stands in torrent on the rugged Alaska Peninsula. Except for mating individuals and associations like this between a sow and her cubs, bears seldom come to within paw-striking distance of one another.

MOCK-FIGHTING occupies most of time and attention of young bears, *above*, when they are not eating or sleeping.

CARRYING A SALMON, female leads her cub to safe distance from other bears before she will allow it to eat, *below*.

Gulls wait for a chance to pick at the remains of salmon. These birds, along with ravens, magpies, and even bald eagles, congregate at such fishing sites.



"teddybear" stage. When not eating or sleeping they appear to be constantly playing, tumbling, or mock-fighting with one another. Yet, even when playing, cubs usually watch the adults, and scamper away when approached by them. Occasionally the young become so engrossed in their play or in eating that they do not see the approach of a larger bear. But the watchful sow is aware of the danger, and, with a warning woof and the fur on her prominent shoulder hump standing on end, she fiercely charges the invader. An aroused female protecting her young is a formidable adversary, and one that other bears will avoid. Not infrequently, after a sow has routed an invader she will turn swiftly and cuff her offspring, presumably because of its failure to avoid the danger. Such cuffs are not lightly given but are solid blows sufficient to send the cub head over heels. After such a chastisement the cub temporarily becomes obedient, whimpering and scurrying to safety behind its mother. But cubs, like most young, are too full of mischief to remain long subdued, and shortly begin to play. They eventually get into further trouble, which is followed by another reprimand.

Sometimes a cub, attracted by the splashing or sight of salmon in more quiet waters, attempts to fish by himself. If he chooses a dying or dead

TRIPLETS are not unusual among the brown bears. These cubs are still too small to fish successfully for themselves, salmon he may succeed in dragging it onto the shore, but if the fish is large and vigorous, the cub's chances of success are slim. Few sights are more animated or ludicrous than the usually brief battle between a small cub and a fresh-run salmon.

Normally, spawning salmon are readily available in the small tributaries, but the number may be limited. Under such conditions, bears may be intolerant of each other's presence in the competition for food. Occasionally one animal claims a section of stream as private fishing territory. When not fishing, he guards this section from a vantage point 50 to 100 feet from the stream, in order to observe any encroachment. When another bear attempts to enter these fishing waters, the "owner" promptly notifies the invader of its presence. On a few occasions I have witnessed a territorial possessor approach a smaller invader, whereupon the latter retreated. Once I saw a larger invader enter the territory of a smaller possessor, which, rather judiciously I thought, relinquished its claim. From the noise of presumed battles that I have heard but unfortunately never witnessed, it seems probable that occasionally neither bear retreats. Roars, woofs, and growls that emanate from such an encounter are indeed awesome. I visited one locality after hearing what was apparently a battle, expecting to find a dead bear or at least a gory mess. All I found were trampled grasses and bushes.

Bears, like most other animals, seriously fight only over food or a mate. Normally they bluff, each attempting thereby to establish a peck order, or dominance, over the other. The method of gaining dominance frequently follows the same pattern. Two bears approach each other on a trail. When aware of the other's presence, each rears on its hind legs to its fullest height—for height appears to be of great importance in gaining superiority—with the forepaws widely outstretched. Each stands still, watching closely, or paces back and forth parallel to, *not* in the direction of, the other, while emitting loud growls, grunts, and woofs. Eventually one drops on all four feet and either detours around the adversary or retreats. Sometimes both, as if by common consent, drop to all fours and by-pass each other.

Several published references describe the way bears capture salmon

and would probably lose a contest with a vigorous salmon. Sow may fish in deeper water, leaving her young in shallows.

with their feet, either by knocking the fish from the water onto the bank with a rapid swing of the paw, or by striking it violently to incapacitate it. This is quite possible, I suppose, but not one of several qualified observers of bear behavior whom I have interrogated has ever seen such a performance, nor have I. Many times, however, others and I have watched a walking or standing bear that was seemingly peering into the water suddenly grasp a salmon between its massive jaws. Occasionally, when otherwise unsuccessful, a bear would rush rapidly through the water, thereby frightening the fish so that they came within his reach or became stranded in shallow water. I have seen a bear reach under a log with its forepaw, obviously attempting to herd any hiding fish into the open.

Much has been written, especially by hunters, on the ferocity of the brown bear and its willingness to attack man. But those who have studied the animal's behavior are agreed that, although at times unpredictable, the bears have not been seen to attack unless provoked. However, observers of the closely related, smaller grizzly believe that they will attack for no obvious reason.

Dr. Trautman, who is curator of the vertebrate collections at the Ohio State University Museum, Columbus, has observed the feeding behavior of brown bears on his trips to Alaska.

Although apparently loath to fight without cause, a "brownie" does not hesitate to charge when occasion demands. If you try—as some inexperienced observers have done—to walk close to a cub to take its picture, or to get between a cub and its mother, you are in for trouble. Wound a bear and it will charge. Walk carelessly along a stream containing spawning salmon and into the private fishing territory of a large bear and it may use its age-old right to dispute possession. If you place bacon, other meat, fish, or vegetables in tents, cabins, or automobiles, a brown bear may claim the territory, after which *you* become the invader.

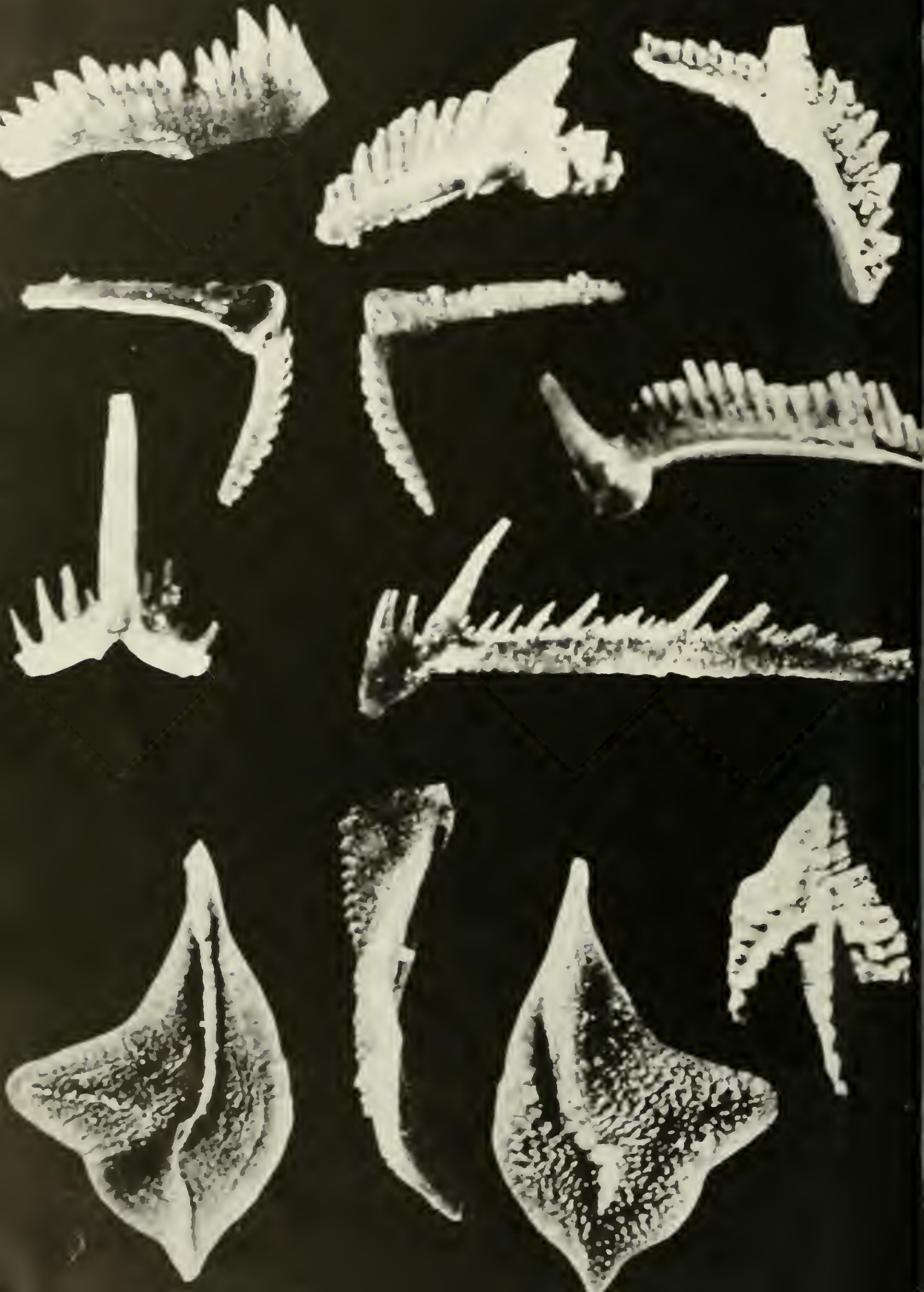
More impressive to me than attacks on humans is the way in which these animals respect man and avoid him. This is especially true when a person blows a referee's or a policeman's whistle. Usually when I blew my whistle an approaching bear instantly retreated, sometimes running across the tundra until I ceased blowing. Acting on the basis of observed bear behavior, and upon seeing a not-too-large bear approach, I use their own techniques. I stretch to my fullest height, wave my arms and gun overhead, alternately shout and blow my whistle, and walk back and forth but not toward my rival. Ordinarily the bear retreats, but if it does not, I do—slowly and, I hope, with dignity. If, unintentionally, I come within a few feet of one, I do not frighten it into charging, but instead retreat with my gun—which has never been used on a bear—at the ready. Once a safe distance away and beside an easily climbable tree, I sometimes childishly blow a whistle blast, if only to assert man's vaunted superiority.

Probably 1,000 pounds of bear respects the whistle because the high, shrill notes hurt its sensitive ears. This animal is perhaps not more aggressive because for centuries, and until the advent of hunters with their guns, it had no predator to fear.

All large animals are impressive, but for me none has the strength, dignity, and beauty of a brown bear. I hope the Alaskan coast and islands always contain these animals and the abundant supply of salmon on which they are able to feed for a brief season each year.

If fish are plentiful, bears remain amicable on fishing grounds; if scarce, certain animals may claim territories.

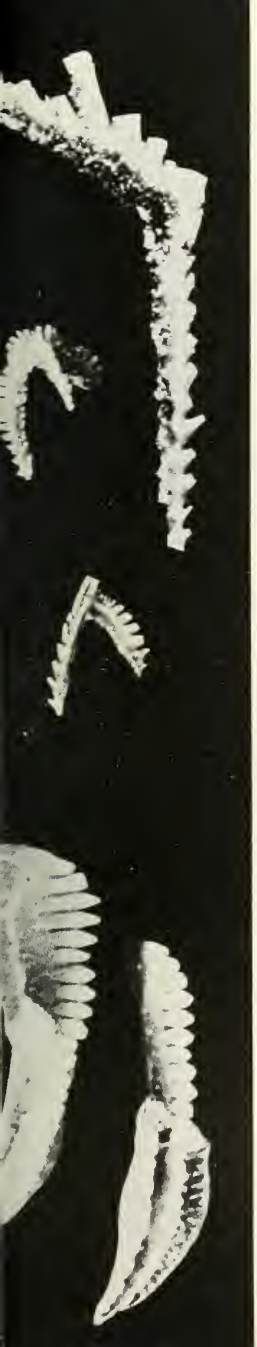
Aroused sow is formidable adversary. Young stay behind her as she charges an adult that came too close to them.



Problematic Conodonts

Origin of toothlike fossils is unknown

By David L. Dineley



Silurian and Devonian rocks of North America and Europe have yielded these dentate and platform conodonts, which are between .5 to 3.0 mm. in length.

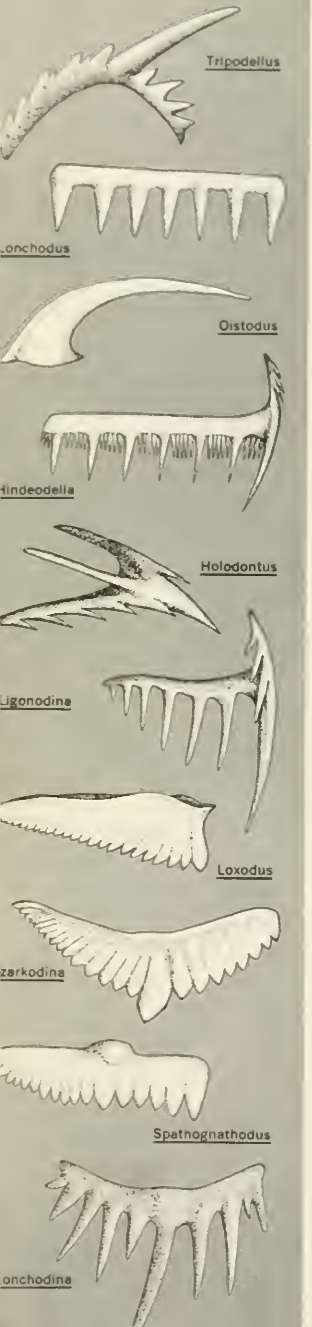
Almost every kind of fossil presents the problem of reconstructing what it looked like when it was alive. With many fossils this is soon solved more or less satisfactorily; it is not so easy with incomplete and unusual fossils; it becomes extremely difficult with those unlike any known living organism. This is what the micropaleontologist faces when dealing with the conodonts—minute, toothlike, phosphatic fossils. As they are generally between .5 and 2.0 mm. long, these fossils were apparently parts of a group of small, though by no means microscopic, animals, yet they do not seem to be directly comparable with any modern organisms.

Conodonts were first described in 1856 by C. H. Pander from the Silurian rocks of the Baltic area of Russia, where he found them in association with the remains of primitive fishes. Later discoveries have shown them to be virtually of world-wide distribution. Up to the present decade, very many paleontologists have regarded them as teeth of early or primitive vertebrates. There are, however, several reasons why this view must be questioned. Paradoxically, the fossils present two features that are apparently mutually exclusive in other organisms. They are of a phosphatic composition peculiar to vertebrates, yet have a morphology closely akin to that of errant polychaete worm jaw components. Were they parts of a wormlike animal? Animal groups seem to be conservative in their physiology and in the utilization of hard materials, and I favor linking conodonts and vertebrates on the basis of hard-part composition.

Not everyone agrees with this viewpoint, and the fossil evidence on either side is extremely slender. No one has ever found a complete conodont-bearing animal in the fossil state, and usually the conodonts have been found completely isolated from one another and with no obvious association with any other fossilized remains. Between the time Pander published his accounts and the 1920's little was added to our knowledge of conodonts. Then an article by Drs. E. O. Ulrich and R. S. Bassler in the *Proceedings of the U.S. National Museum* redirected attention to them. Since then they have received a great deal of notice, and they are now being studied in paleontological laboratories in North America and Europe, especially in the United States and Germany. Somewhat over fifteen hundred species are known today, but despite many papers on the subject, no one has yet come forward with a completely satisfactory suggestion as to what the conodont-bearing animal really was.

The fossils are found in ancient marine sediments, never in freshwater or continental deposits. Shales and limestones yield most of them. Since the fossils are composed of calcium phosphate they are, in the laboratory, usually etched from limestone by acetic or formic acid. Even where the rock has been metamorphosed to distort or even to destroy most of the macrofossils, the conodonts remain intact, and quite small rock samples will often yield large numbers of them.

This has made them of great potential value in subsurface geology, where drill chippings or drill cores may not be large enough to provide the macrofossils normally used to date the strata.



Varied forms show major features of conodont "genera." With the exception of cone-shaped *Oistodus*, all have fangs and denticles rising from elongate base.

Black shale of Mississippian period yielded this specimen of often common

Their use in the subsurface geology of oil fields in Canada, for example, is now increasing each year. Usually two or three pounds of limestone will yield between twenty and five hundred conodonts (or none at all!), but instances of quite phenomenally high yields from this size of sample are known. From both the Ordovician and the Devonian rocks of the eastern United States rare hauls of many thousands of conodonts and other phosphatic organic fragments have been taken. Being relatively heavy particles, the conodonts may have been winnowed from the lighter bottom sediment by currents, and collected in hollows as "lag concentrates." Although the fossils are here in welcome profusion, the winnowing process has usually damaged the delicate types.

Conodonts first appear in beds of Middle Cambrian age (about 550 million years old), and so arrive on the scene before many of the major groups of marine animals. They survived the Paleozoic era to continue into the Upper Triassic in fair numbers, and have even been reported from Cretaceous rocks. This gives them a geologic time range of at least 350 million years, a range (from Middle Cambrian to Upper Triassic) that does not coincide exactly with that of any other known group. In addition, the conodonts have no known descendants.

The phosphatic composition of conodonts, falling as it does within the apatite mineral series, is essentially similar to that of "bonelike" fragments that are sometimes found with the conodonts, and to that of the bony armor of Devonian fishes. It is not a material used to any extent in the hard parts of invertebrates. This is not to say that various invertebrates do not use calcium phosphate in their hard parts, but that this particular *form* of phosphate seems to be utilized only by vertebrates. Indeed, teeth seem to be the closest comparable structures from several points of view. The fangs, or cusps, are often needle-sharp. At the base there is often a deeply excavated cavity, and sometimes a trace of bony material is found adhering to the walls. Conodont structure is one of successive lamellae of clear or amber-colored material, for the most part concentric upon the basal cavity. Professor Walter Gross, a German authority on early vertebrate tissues, concluded from a study of conodont histology that these fossils could not have been formed by a cuticula, as are arthropod skeletons and annelid jaws, and that they are neither true teeth nor skin denticles of vertebrates. He demonstrated that conodonts had

Hindeodella pachyamba Stanley. It is 3.0 mm. long and unusually complete.

no pulp or dentine, and grew by outer addition rather than by secretion from within. Apart from this, their intricate shapes suggest no kinship with any known type of vertebrate endoskeleton (including teeth).

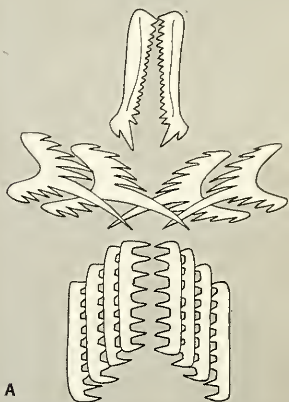
In morphology, the conodonts tend to fall into a number of broad types, as shown in the accompanying drawings. Fancifully, one might distinguish canines and molars among them, but they show no signs of having fulfilled the functions of teeth. A few instances are known of conodonts that were apparently broken while they were alive and that subsequently grew new parts. There is one record of a broken piece that became rewelded to the main structure. Some of the "rejuvenated" parts, however, may be abnormalities rather than true regenerated portions.

The wide variety of form found in conodonts might suggest that they are actually parts of several kinds of structures, each designed for a different function. Yet it is possible to distinguish an "evolutionary series" of conodonts that shows a passage from one kind of basic form to another. In the "natural assemblages," segregations, or "nests" of the fossils described below, widely different conodont shapes occur together, and are thought to be the remains of a single animal.

Some years ago, fine black shales from the Upper Paleozoic of North America were found to contain conodonts gathered into small groups or concentrations of a fairly uniform kind. Professor F. H. T. Rhodes found that these assemblages contained either an arrangement of three or more "genera" of conodonts in an anteroposteriorly extended pattern, or were made up of many pairs of a single "genus." Other workers have found the same sort of thing. Dr. Hermann Schmidt of Germany reconstructed a Carboniferous conodont assemblage and thought it represented mouth and gill structures in a placoderm fish. A great deal is known now about the placoderms and Schmidt's idea has been dropped. Although most of the conodonts in these assemblages occur in pairs, and are either "left-hand" or "right-hand" components, some peculiar types always occur singly and lie, presumably, on the median line. A single animal thus possessed several types of conodonts.

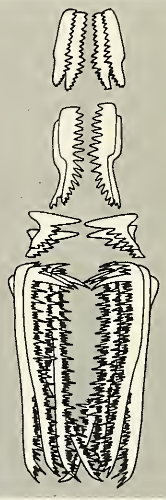
At this point we may note that Pander and all later workers have given conodonts generic and specific names on the basis of their shape ("form-genera," or, better, "partial-genera"), yet these fossils are mostly components of a single type of animal (a "natural genus"). To avoid total confusion, new taxonomic names have been given to

ASSEMBLAGES



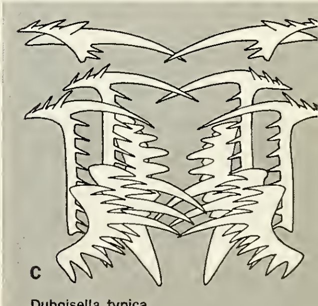
A

Illinella typica



B

Lochriea



C

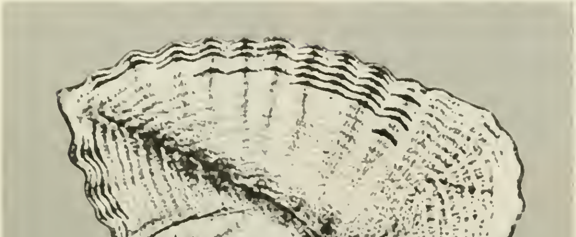
Duboisella typica

IDENTIFICATION of "form-genera" was made from (A); first assemblage to be accepted was (B); fragments (C) allowed reconstruction of natural genus.

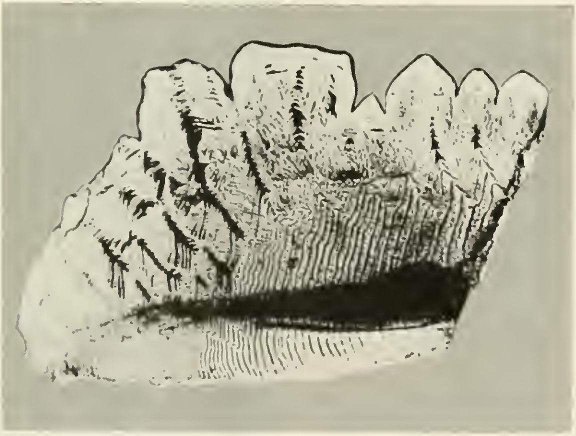
each of the different conodont assemblages. Some authorities object to this procedure, however, saying it is superfluous and out of keeping with strict taxonomic practice. Discussion of this problem of dual classification and nomenclature still goes on. The problem is, of course, not confined to conodonts: other fossils give rise to exactly the same situation.

As seen in the drawings on page 23, the conodonts are visualized as groupings around or along a central axis, no doubt a gut, pharynx, or such cavity, with the fangs directed inward and perhaps backward. Beds that yield primarily one kind of conodont suggest that some of the assemblages were either specialized or primitive in that they contained only one type of unit. No other hard animal parts have ever been found in frequent and undeniable association with any of these assemblages or faunas, so a question is immediately posed: What was the function of the conodont battery and what were the affinities of these animals?

Signs of abrasion, such as some specimens show, do not necessarily mean that the structures were exposed to wear and tear in life; post-mortem damage must have been very frequent. Although some students have suggested a tooth function, it is not easy to accept. Radular teeth in mollusks have been suggested as comparable, but the two types of animals do not necessarily occur together nor do they even favor the same environment. Their chemical compositions are quite different, and the numbers and arrangements of the units within the assemblages are quite dissimilar. Although arthropods produce superficially similar structures, they do so in a different way, and the structures are not composed of calcium phosphate. Scolecodonts, which are the minute teeth of annelid polychaete worms, are often shaped like conodonts, but they are chitinous and their interior structure is quite different.



LAMELLAR STRUCTURE of *Siphonodella* is clearly visible, *above*. Layers are concentric on the central basal cavity that remains on undersurface of unit.



OUTLINE of *Solenodella* blade normally is sharp, but here is deformed by the suppression and subsequent regrowth of some cusps. Layers, too, are irregular.

It also has been claimed that conodonts were internal skeletal supports, covered by protective tissue—possibly a respiratory system. It is, perhaps, more likely that the assemblages functioned as ingestive aids on a protrusible pharynx. If not actually used for tearing or crushing food, they would not necessarily show signs of wear, and (apatite) phosphate is a relatively hard substance.

It is worth noting that conodonts occur in all kinds of marine rocks, even in those black shales that accumulated under conditions stagnant enough to exclude the presence of the usual bottom-dwelling animals. Hence it is likely that these minute creatures may have been swimmers (or floaters) in the surface waters, feeding upon plankton and other minute organic debris. The bilateral symmetry of the conodont animal (as seen in the symmetry of the assemblages) also suggests that the creature was able to move about actively. So far, we have little knowledge of the microfaunas of the Paleozoic seas, but they were probably prolific sources of food, suitable for the conodont animal.

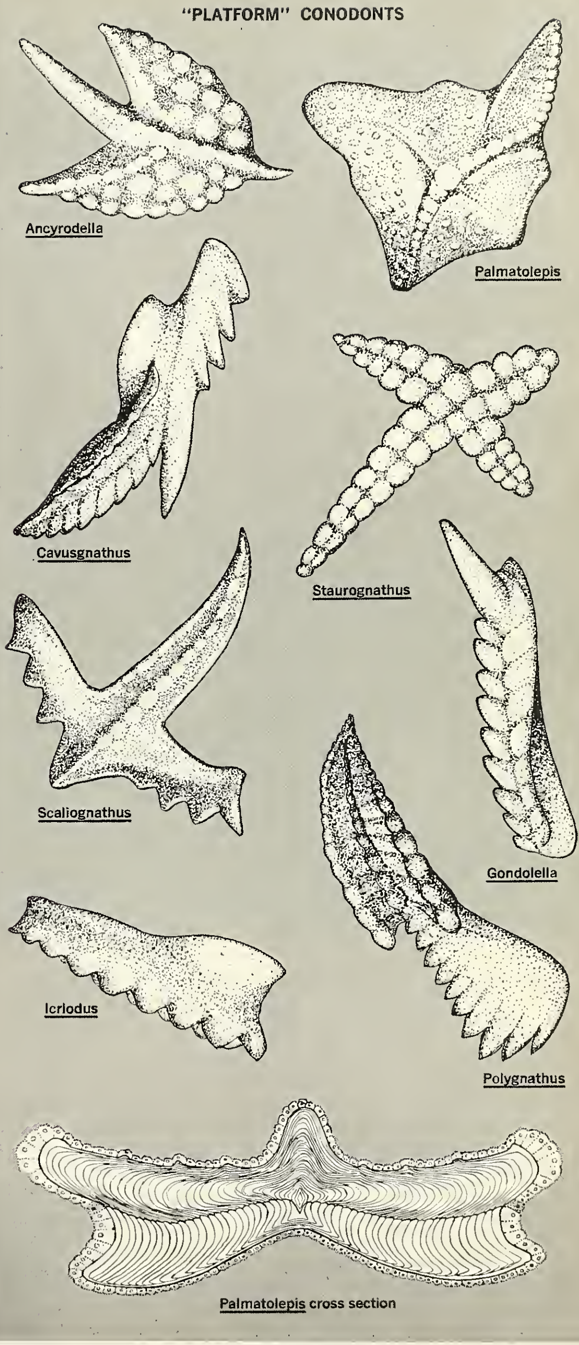
Of all the arguments put forward to suggest kinship to the fishes, only that relating to phosphatic composition has much weight. The chemical structure of the material involved seems to be exclusive to the vertebrates. Gross showed that conodonts do not belong to a vertebrate endoskeleton (or a gill apparatus). Could the animals have been some form of early and primitive

Dr. Dineley is especially interested in ostracoderms and conodonts, and is Associate Professor of Biology at the University of Ottawa, Canada.

lancet-shaped worm or chordate, vagrant, nektonic. and feeding on microscopic seafood particles? The ability of the protochordates to produce calcium phosphate has been denied. but the lowest of the true chordates manage it. Modern protochordates, animals that begin to approach the vertebrates in their organization, do not use calcium phosphate for skeletal parts, but true vertebrates, even the most primitive fish—both those living today and those of Paleozoic times—have employed it.

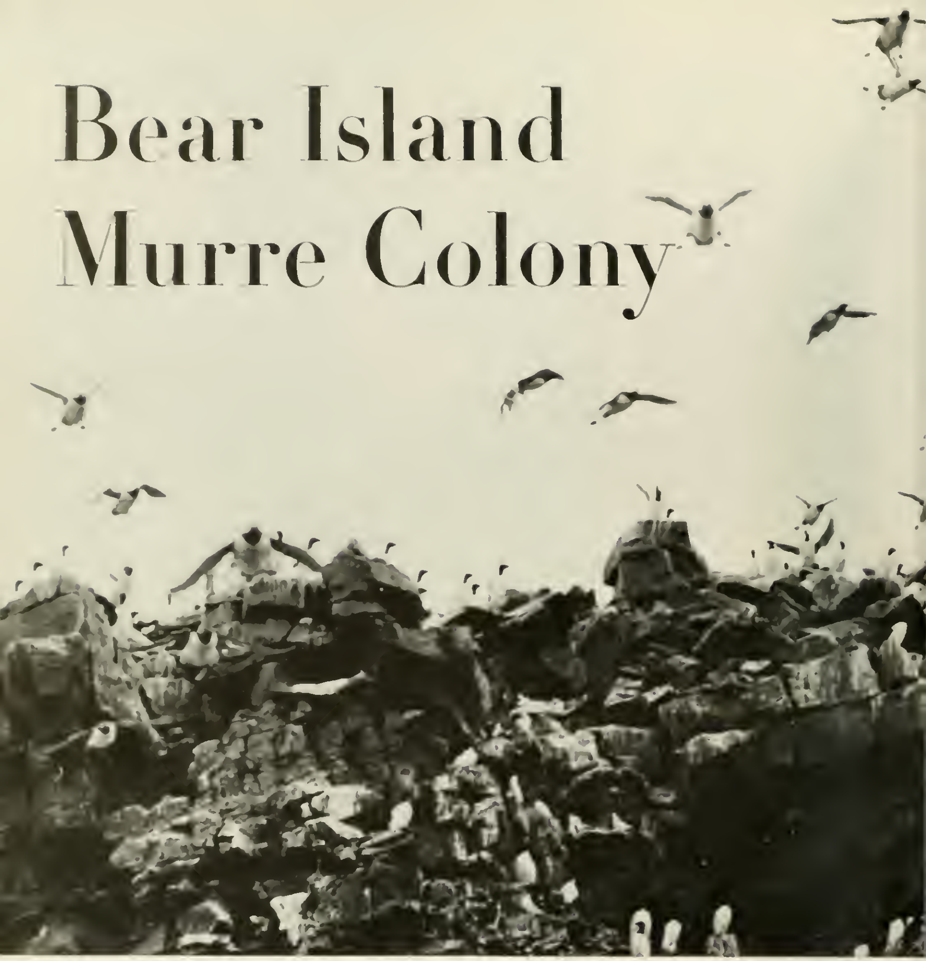
Whatever the animal was, it was widespread. as the same partial genera are known in America, Europe, and Australia. Radiation was rapid and wide. The oldest conodonts are those reported from the Cambrian of Sweden and Germany by Dr. K. J. Müller. From Ordovician to Triassic times they evolved rapidly. Lower Paleozoic conodonts are generally rather simple in form and their cones are most useful stratigraphically. Many new and important types occur in the Devonian rocks, and the Devonian was probably the apex of conodont development. Some conodonts in these and later rocks are most common in the vicinity of coral and other types of reefs, and may have been adapted to this type of environment. Thereafter, the Upper Paleozoic rocks yield new elongate platform types in large numbers. Triassic conodonts are known from North America, Germany. Spitsbergen. and the Near East, but there are noticeable differences between the faunas of these regions. and many fewer species are present in the rocks of this period. Conodonts reported from later rocks. such as those of the Cretaceous. may, in fact, have been incorporated as detritus from previous conodont-bearing sediments; in any event, a long record is involved —some 350 million years from Cambrian to Triassic!

One day we may find that some unusual sort of preservation has left in the rocks a more complete conodont animal than we know at present, thus solving a long-pondered problem.



Paleozoic rocks yield these forms. At bottom is cross section showing the epithelial cells that secrete phosphate.

Bear Island Murre Colony



Dense populations seem to be required for optimum reproduction in these alcids

By Eugene Eisenmann

Some 240 miles north of Norway, well above the Arctic Circle in the Barents Sea, rises isolated Bear Island. Rugged and rocky, fogbound much of the time, it is largely a barren, high plateau, dotted with lakes and tarns, and bordered by magnificent cliffs that in places drop over 1,100 feet sheer to the sea. In this area there are great bird colonies living on the teeming richness of the ocean, which is most productive where there is a vigorous vertical circulation of water.

Of the many sea birds known to breed on Bear Island, reported by G. C. L. Bertram and D. Lack to include hundreds of thousands of fulmars, tens of thousands of gulls (chiefly black-legged kittiwakes and glaucous gulls), and thousands of eiders, the most conspicuous are the auks. Six species of auks, or alcids, breed on Bear Island; by far the most numerous are the murres, which are called guillemots in Britain. The name murre—said to be derived from the deep murmur of their voices—is applied in the United States to two medium-sized, somewhat penguin-like birds, which are called respectively common murre *(Uria aalge)*, and thick-billed, or Brünnich's, murre *(Uria lomvia)*.

Like many other birds of the far north, the murres have a circumpolar

distribution. Common murres breed chiefly on islands in colder parts of both the North Atlantic and North Pacific oceans, ranging south to Nova Scotia and northwestern France in the former, and to central California, in the latter. The thick-billed murre has everywhere a more northern breeding distribution, being chiefly a bird of arctic waters in both oceans. The two species occur together in a number of places, including Bear Island, where Bertram and Lack found them breeding side by side on the same ledges indiscriminately, although the common murres were more numerous. Interestingly enough, it is the more arctic thick-billed murre that bird watchers are likely to observe in the vicinity of New York during cold winters. Probably this is explained by the freezing of their northern feeding waters, which forces them to fly southward.

On their breeding grounds, murres crowd together on cliff ledges and overflow, at least in the case of the common murre, over more level plateaus and even low rocky areas. Since their wings are small, they prefer cliffs from which they can become airborne by dropping over the sea, because it is hard for them to rise aloft from level ground unless they are facing into a fairly strong wind. On land, although usually maintaining a rather erect posture, murres stand with the tarsus horizontal on the ground. They move with a clumsy waddle, scraping along on the tarsus, rather than on their toes, as do most birds. In flight they beat their short, pointed wings in a rapid whir, and open their webbed feet on take-off and landing. The diminutive tail is apparently too short to serve as a steering mechanism.

R. W. Storer, who has published an elaborate study of these alcids, has described their method of locomotion.

COMMON MURRES, huddled on the rocky outcroppings, are one of the six species of auks that nest in area with fulmars, eiders, gulls, and many other sea birds.

ARRIVING BIRDS are clumsy, and may knock against their neighbors or push eggs to the rocks below. Webbed feet are opened for take-offs and landings.

Conservation and bird distribution are interests of MR. EISENMANN, a Research Associate in THE AMERICAN MUSEUM'S Department of Ornithology.

While the feet are used in a paddling movement when murres are floating or skittering over the surface to attain air flight, the characteristic method of movement is underwater "flight," in which the partly open wings are rapidly "rowed" and the feet serve for steering. Most of the food of murres consists of small fish, crustaceans (such as small shrimp), and sometimes squid secured beneath the surface. It is said that the birds dive to a depth of fifty feet or more and frequently stay under water for forty or fifty seconds, sometimes considerably longer.

According to R. A. Johnson, nesting colonies of common murres have a definite structure. In addition to the breeding areas, and a feeding area at sea, there are loafing grounds where non-breeding birds congregate and where breeding individuals often land. The actual breeding sites are dense aggregations of birds, which give the colony the appearance of a confederation of distinct breeding groups. In each group the central and preferred position is occupied by pairs that lay eggs first—presumably older birds that arrived early and had bred on the same site before. The peripheral positions are more subject to disturbance from interloping non-breeders and, doubtless, from predators. Close proximity to other birds seems essential to successful murre reproduction.

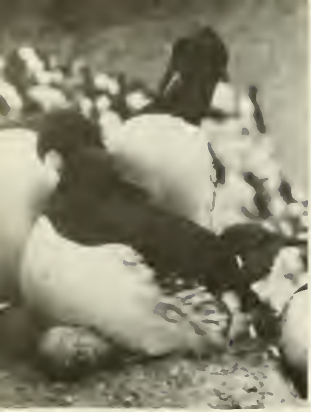
MURRE colonies present a scene of constant and noisy activity. Individuals leave and arrive; landing birds clumsily skid or knock into their neighbors. Adjacent birds fence with their bills, and there is considerable wing-flapping, preening, and bowing. Bowing is stimulated when birds are disturbed, and if one individual starts to bow, all in the group sometimes join the performance.

The sexes of murres look alike, and both participate fully in the incubation and care of the young. The single egg is laid on the bare rock. There is no nest, but sometimes a small stone is brought in and placed under the egg by an incubating bird. Murre eggs are remarkable in several respects: they are very large, weighing about 10.6 per cent of the weight of the adult; they are decidedly pear-shaped, with a narrow, almost pointed, small end; they are extraordinarily variable in color and markings. Probably no two eggs are exactly alike. The peculiar shape is believed to be an adaptation to reduce the chance of the egg rolling off the narrow cliff ledge, for when it is moved it is likely to rotate, toplike, on its side. Johnson suggests that this shape facilitates incubation, as the parent holds the egg on the tarsus, covering it from above with the loose, bare skin of the incubation patch.

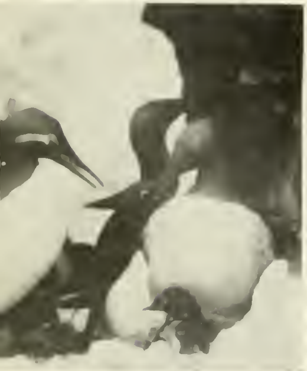
DESPITE the shape, many eggs do get knocked off cliffs by the constant activity on a crowded nest ledge. The pattern and color variability of the eggs has been supposed to facilitate recognition by a parent of its own egg. Johnson experimented with common murres, exchanging eggs from nest sites some eighteen inches apart. Each parent moved its own egg back to the original site and incubated it. He reported seeing birds roll displaced eggs back to the original location from distances of one to five yards. On the other hand, S. M. Uspenski, in his detailed account of Novaya Zemlya sea birds, says of the thick-billed murre: "Egg color . . . plays no part in the orientation of birds on nesting ledges. The birds invariably continue to sit even on eggs of other species, differing greatly in color, shape, and size from their own." The difference in these observations may perhaps depend on the stage of the incubation cycle or the distance to which the egg is removed from the nest.

There is no doubt that murres have the greatest attachment to their exact nesting sites. The same pair of banded birds has been found returning in successive years to the same site. In a crowded colony, there seems to be a shortage of suitable or socially acceptable sites within a nesting group, and a large number of birds in breeding condition remain on the outskirts waiting to take over any vacated space. If an egg is lost during the first few days of incubation, most females, according to Uspenski, will re-lay about sixteen days later, and a very small proportion will lay even a third egg as replacement. The incubation period is variable, probably depending on the extent of disturbance at the nest. It usually runs between thirty and thirty-five days, but as many as forty-nine days have been reported as elapsing between laying and hatching.

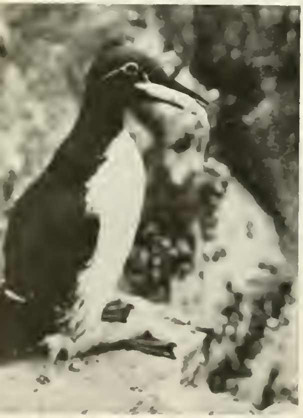
TAKE-OFFS can be difficult for these small-winged birds unless they face a strong wind, so they become airborne by dropping from cliffs over the sea.



PEAR SHAPE of egg may be adaptation to reduce the chance of its falling from ledge, as it rolls like a top on its side.



WHITE RING, extending in line back of the eye, gives name "ringed murre" to one color phase of the common murre.



At first, incubation is intermittent; the birds often leave the egg unattended for considerable periods. But at this stage, if a man enters the colony he may stimulate a mass flight of the entire group of nesting birds, with the resultant loss of many eggs. Later, the eggs are incubated almost constantly by one or the other parent, and during this period a person may touch or even, on occasion, remove an egg from under a sitting bird.

A remarkable feature of the thick-billed murre on Novaya Zemlya in the Arctic Ocean, as reported by Uspenski, is that about 5 per cent of the eggs lose part or all of their calcareous shell in the latter stage of the incubation period, yet the young complete their embryonic development although protected only by the tough membrane that lies inside the shell.

When the chick hatches, it is covered with dense, stiff down that looks rather like fur. For the first three days the chick is helpless and is almost continuously brooded. After that it begins to move about on the ledge when its parents are away, and may take shelter under the wing of a neighboring sitting bird. Usually such birds are hospitable, and it is not remarkable to see an adult brooding two to four chicks, or leading a couple of fledglings in the water. Brooding and feeding of chicks by the neighboring adults when parents are absent is presumably one of the advantages of densely populated nesting colonies. When the young are nearly twenty days old and fully feathered, but while their wing quills are still ungrown, their parents cease to feed them. Finally, hunger, assisted by the encouragement of calling parents flying near the ledges, induces the young to fly. With rapidly beating, only partly grown wings, the young drop off the cliffs and fall into the sea or sometimes on to the rocks below. Adults at the bottom of the cliffs may lead chicks from the rocks to the water. The young follow adults for some time. They do not become sexually mature until the third year, and probably not all of these secure nesting sites in the colony. Some murres live at least ten years, judging by banding returns.

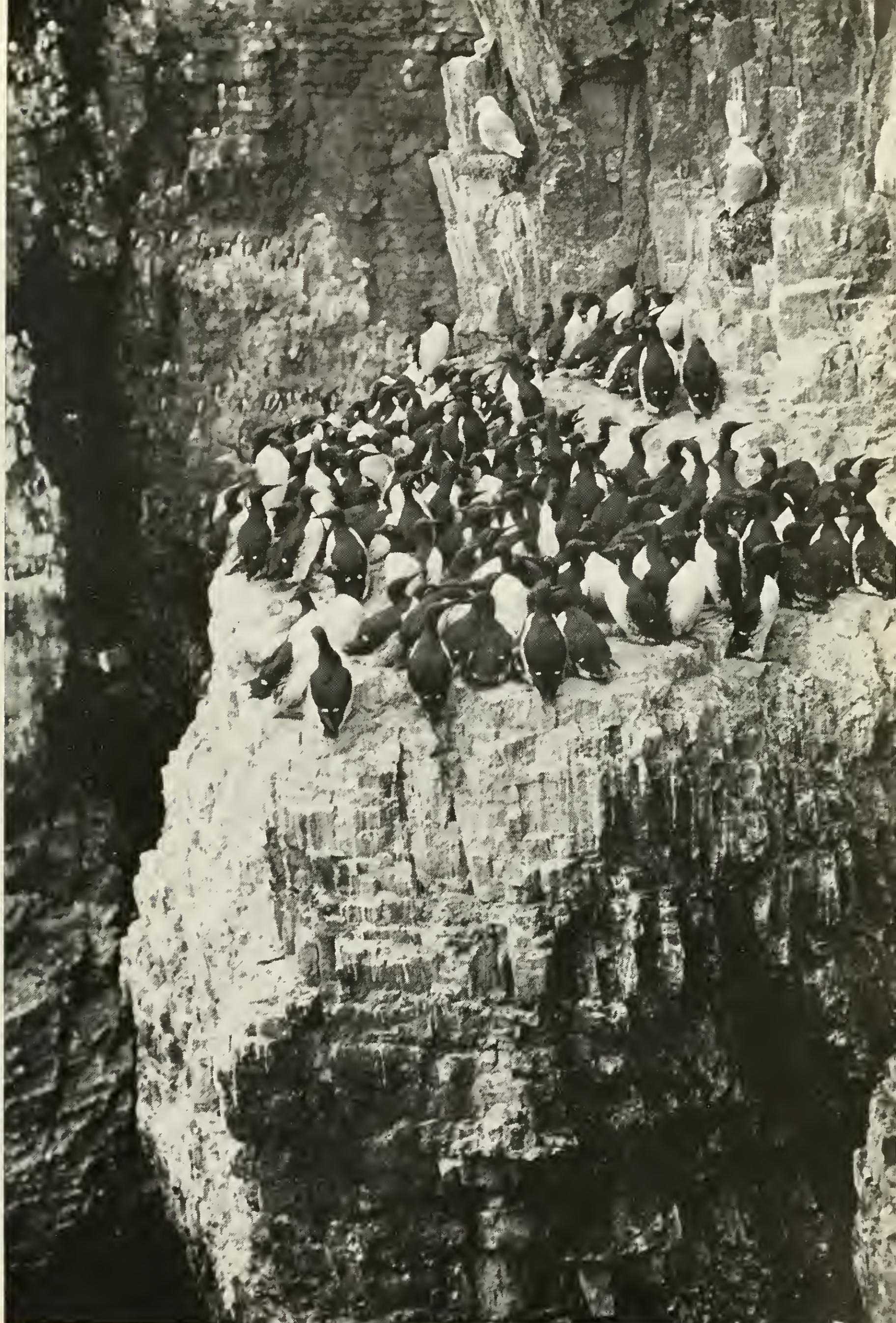
It is not easy to distinguish common from thick-billed murres. In breeding dress both are blackish above with dark brown throats and necks, and with white lower under parts. The thick-billed murre has a whitish line along the basal edge of the upper mandible. The common murre is somewhat smaller, but has a more slender, longer bill. There is a distinctive color variety of the common murre that is called "ringed murre," a white eye-ring extends as a line backwards. This ringed color phase (which is easy to distinguish from the thick-billed murre) does not occur in the Pacific populations, and is rare in the southern part of the Atlantic range, but steadily becomes more common northward, until on Bear Island and Novaya Zemlya, ringed birds are at least half of the common murre population. Ringed and unringed birds interbreed freely.

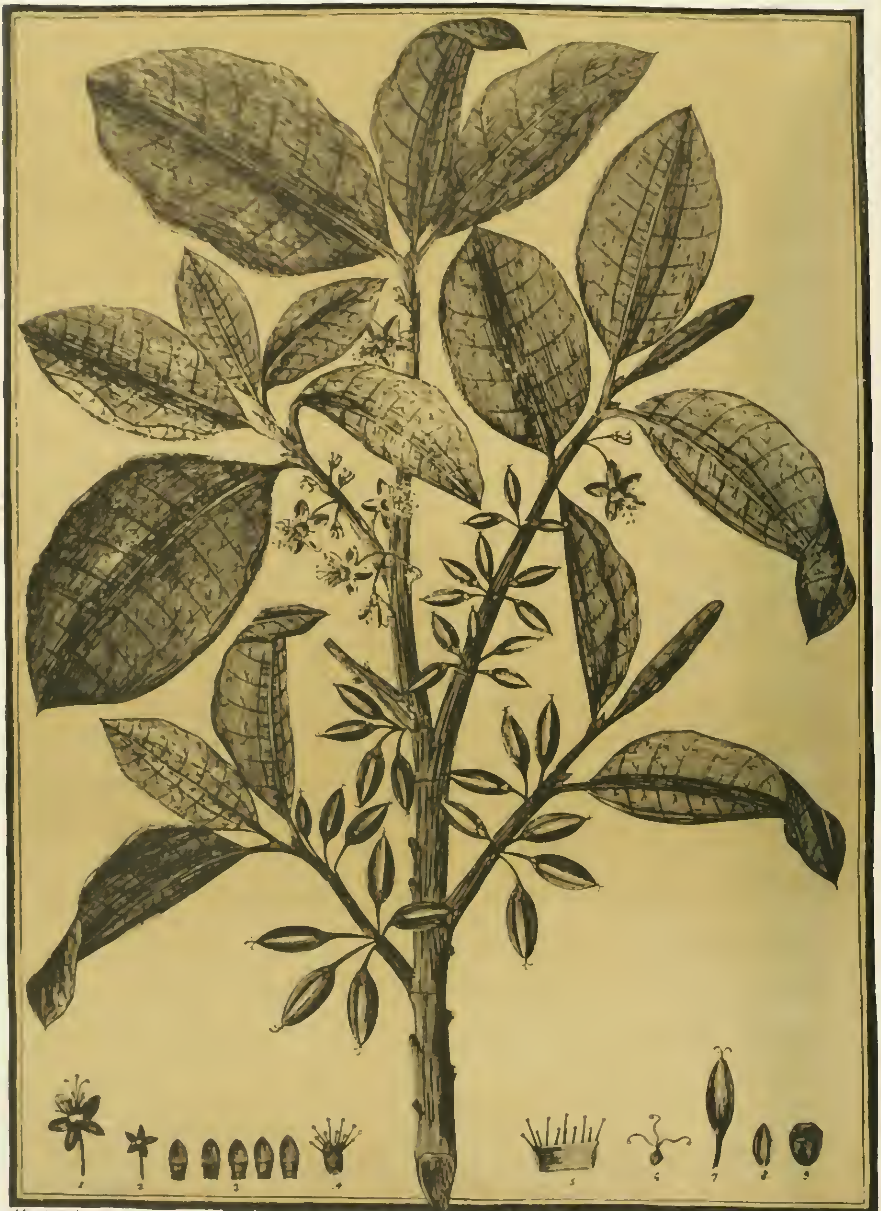
Aside from man, the murres' chief predators in most colonies are the larger gulls, which are prone to take exposed eggs, especially if the population is not dense. In some of the larger islands arctic foxes take a toll, but in most places murres live in areas where resident mammalian predators are absent. The small marine gulls known as kittiwakes, which also use cliff ledges for nesting, may be somewhat competitive for breeding sites, but the Russian ornithologists report that in well-populated murre colonies the latter oust the kittiwakes and that in scantily filled ones, the presence of the gulls helps to provide the population density needed to induce breeding.

In many areas, colonies have been destroyed by man's commercialized or indiscriminate egg-collecting, but where the eggs are cropped but once and at the beginning of the nesting season, the ability to re-lay permits the replenishment of the population. In Russia, careful biological studies have been made to work out the best method of cropping colonial sea birds in order to provide food for man and at the same time to maintain the bird population indefinitely. Over forty-five colonies on Novaya Zemlya were in 1950 thought to have at least two million murres, chiefly the thick-billed, with individual colonies varying in population from about a thousand to perhaps four hundred thousand birds.

UNLIKE most birds, murres stand with tarsus horizontal on the ground; they also walk on tarsus instead of on toes.

SMALL GULLS, the kittiwakes, nest on narrow ledges above murre colony, and may compete with alcids for nest sites.

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"Divine" Leaves of the Incas

True role of coca use among Andean Indians is still in doubt

By David J. Rogers

Coca means many things to different people. To some of the early Spanish padres who first saw coca leaves used by the Incas (and to some people today), it was evil; to ancient and modern Indians of the high Andes, it is "divine"; to the conquistadors and their followers, it meant a profitable trade and a higher output of labor from the Indians forced to dig in the high-altitude gold mines. Today coca cultivation means a good income for a few ruling class families who have "organized" its production and sale.

We cannot make decisions on the "good" or "evil" of coca use in the light of present knowledge. Most such attempts are based on observations alone, and little controlled experimental work has been done. We do know that an extract from the leaves of coca (*Erythroxylon coca* Lamarck), cocaine, can be a habit-forming narcotic when used intemperately, but we do not know that the leaf itself, when used as the Indians use it, is habit forming. There are, to be sure, people who "habitually" chew the leaves, but perhaps in the same sense that people habitually use aspirin for headaches!

Erythroxylaceae is a family of flowering plants found in the tropics of both hemispheres. Of the two genera in the family, *Erythroxylon* is by far the largest, with approximately two hundred species found in both the Old and New World tropics. The two species that may be chewed *(E. coca* and *E. novogranatense)* are found only in the Western Hemisphere, except those that have been transported and transplanted either to conservatories in Europe or to the Eastern tropics.

Details of coca, one of a number of species in Erythroxylaceae family, are shown in a late 18th-century engraving.

Going from west to east over the high Andes, one passes through the sierras or by plane over them, and descending the eastern slopes of this mighty chain of mountains, one is struck with the fact that there seems to be but one predominant cultivation endeavor. On the sides of steep slopes or on the brows of ridges, at altitudes between about 2,000 and 6,000 feet, large cleared areas can be seen. These are the beautifully prepared, steplike terraces of the coca plantations, called *cocales*. Nor is this local; the same type of plantings may be observed all the way from Bolivia in the south to Colombia and Venezuela in the north of South America.

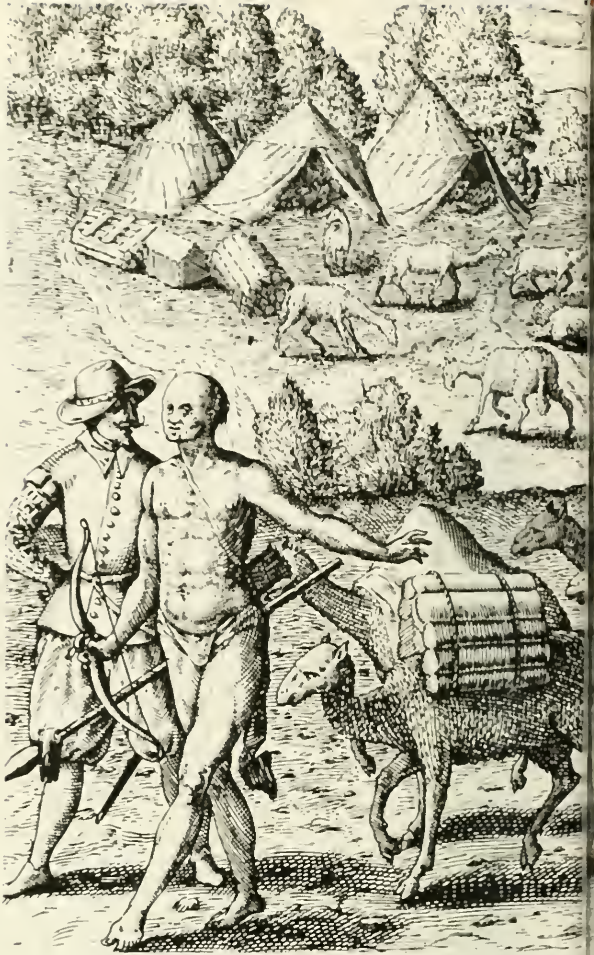
The mature plants in the *cocales* usually reach a height of 5 to 6 feet, and may occasionally be taller. The shrubs appear rather gaunt: if seen shortly after harvesting, they seem on the verge of death, having been nearly defoliated. On many of the plants one may find a species of reindeer lichen (*Cladonia* spp.), which adds to their sere appearance. Harvesting may begin when the plants are two to three years old and continues for about twenty years. Leaves may be harvested from three to six times per year, for in the montaña the rate of vegetation growth is phenomenal. Here clouds moving westward deposit moisture drawn up from the vast Amazonian lowland to the east. The "dry" season of the montaña is that period when it usually rains only once a day.

Methods of cultivating and harvesting the crop have not changed since prehistoric times. The rather beautifully designed, simple leaves, with two veins that parallel the midvein on the undersurface, are picked by hand when they are mature and about an inch long, and carried to smooth, flat drying areas. Formerly these were made of sun-baked clay, but today they are usually constructed of concrete. Great care is taken to protect the drying leaves from moisture, for damp leaves would ferment—a process that would tend to destroy the active principals, the alkaloids. After harvesting and drying, the leaves are placed in a huge wooden screw press that compacts them for shipment to the markets. The leaves I saw being pressed were usually baled in 1- by 3-foot bundles, then wrapped in white cotton cloth for transport. It seems important that there be little delay in the steps between harvesting and marketing, as there apparently are various volatile substances in the foliage that escape if the leaves stand too long before being used. Although some coca may be consumed by those who raise and harvest the crop at the lower elevations, the greatest proportion is transported by truck, burros, llamas, or on the backs of the Indians to the high-Andean centers of Indian population.

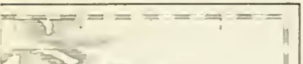
By far the largest quantity of coca goes into commerce in the form of the freshly dried leaves, but some is diverted to governmentally controlled extracting factories where the cocaine is removed. Agricultural statistics for South America are generally more estimated than actual, and those for areas east of the Andes in the montaña of Peru are less reliable than those for coastal zones nearer the large population center of Lima. However, the most recent estimates indicated that about 10 million kilograms of coca leaves are produced annually in Peru alone. In this area, about 40,000 acres are cultivated, but this does not include some more or less abandoned cocales whose productivity has fallen below a point where it is commercially feasible to harvest. Such cocales are allowed to revert to bush, and the older plants may persist for a long period beyond the time when they are actively cared for. This type of agriculture, with its shifting areas, has caused much confusion to botanists investigating the origins of the cultivated coca. Surviving plants from the abandoned *cocales* may give the appearance of wild plants, although they once may have been meticulously cultivated. Nine-tenths of the harvest is home consumed and the remaining tenth is sufficient to satisfy the needs of all the rest of the world.

A common sight in the street markets of La Paz, or other cities with great Indian populations, is an Indian woman vending coca leaves, and nearby another woman selling small grayish cakes of lime *(llipta)* that are almost universally used with the coca. Although varying quantities of coca leaves are shipped abroad, where drug companies extract cocaine, the use of the whole leaf does not seem to have spread far from the areas where the plants are grown.

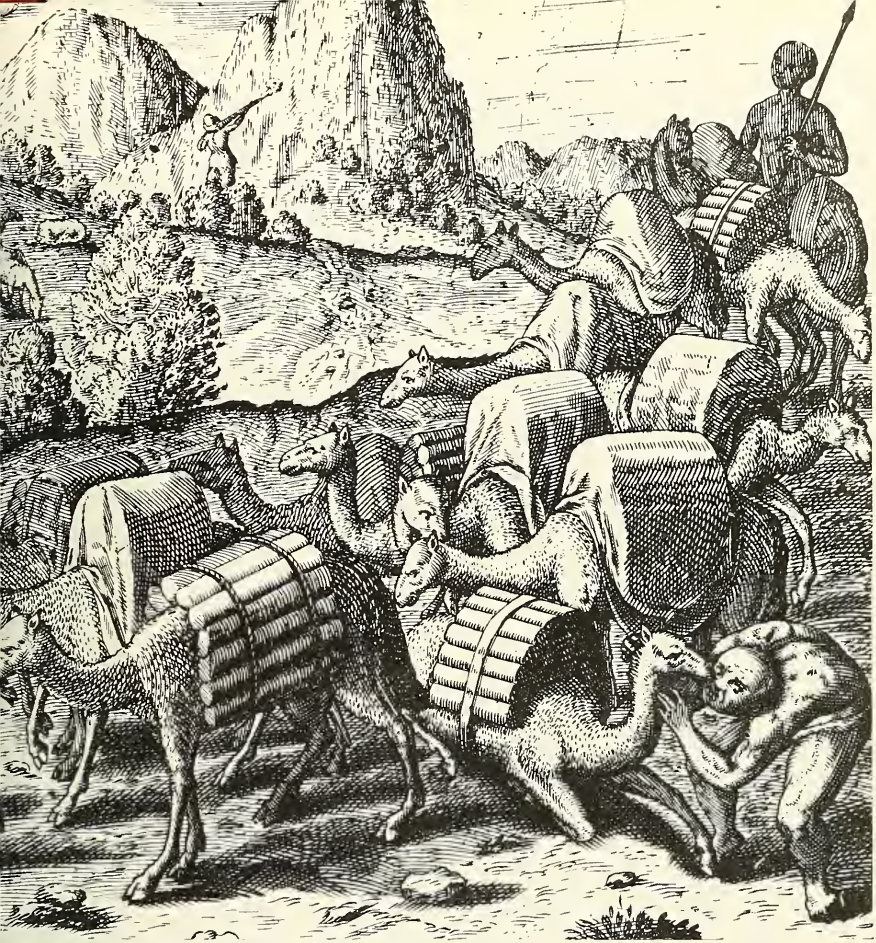
Many scientists have noted that primitive societies the world over, separated from others by mountains, oceans, or other barriers, have independently managed to extract from the plant kingdom various materials that tend to ease their pains or allow escape from an overburdensome world of reality. Thus, in the Near and Far East opium and marijuana were developed; in tropical Asia and the nearby islands betel nut became prominent; in Mexico and our own Southwest peyote, or mescal, was favored. There are many others, all developed long before recorded history. Furthermore, in addition to discoveries of drug-bearing plants, there have developed procedures or methods of use that are similar in widely separated areas. For instance, in order to obtain the greatest benefit from the use of coca, the Indians add a little lime to the leaves they chew (or allow to rest in the cheek) to assist in the release of the active principals. Apparently the chemistry is such that an alkaline solution of saliva makes the drug substances more active. Almost identical in process is that of betel nut chewing in Polynesia and southern India. Details of the actual use vary, but the basic idea is the same, for here, too,



Bundles of coca leaves are still loaded on llamas and are carried to cities as shown in engraving of early 1600's.



Coca use areas, in black, have not spread far from where plants are grown.



Method of wrapping the dried leaves in white cotton cloth has been essentially unchanged since long before Conquest.

lime is a necessary adjunct. The betel nut, from a species of palm *(Areca)*, is wrapped with the lime in leaves of a vine that is a member of the family that includes black pepper.

In 1901, W. G. Mortimer published a monumental work, *Peru, History of Coca,* which is still the definitive study of the plant. Writing in a semipopular style, he has done more than anyone to bring together the early literature on the "divine" plant of the Incas. In addition to his own studies (as a medical doctor), Mortimer received considerable assistance from Dr. H. H. Rusby, Curator of Economic Botany at The New York Botanical Garden, who spent over a year in the Andean regions studying both the plant and the way in which it is used. Both men were convinced that the manner in which the Indians used coca was not harmful, but was actually beneficial in adjusting to high altitudes.

There is little doubt that coca was used by the ancestors of the great Inca civilization in western South America, although we have no good estimates as to how long that use predated the Spanish Conquest. In 1917, W. E. Safford, an economic botanist for the United States Department of Agriculture, wrote that along the Peruvian coast he found mummy bundles—some dating back two to three thousand years—in which the dead were buried with sacks of coca leaves and accompanying lime containers. There seem to be no records to indicate that coca was used in other areas of the world.

One of the earliest chroniclers for the Incas after the arrival of Pizarro's

Dr. Rogers is a plant taxonomist and is the Curator of Economic Botany at The New York Botanical Garden.

band was Garcilaso de la Vega, whose father was a Spaniard who arrived shortly after the Conquest and whose mother was an Inca of high birth. From his mother's side, Garcilaso inherited *cocales* that were first established in 1497 and were located on one of the tributaries of the Beni River in Bolivia. The early conquistadors, notorious for their ignorance of forces other than arms, at first banned the use of coca leaves because they considered it a pagan practice. Later they revised their opinions and not only permitted it, but took control of the plantations and derived much wealth from them. The church leaders who were active in another aspect of the pillage of Peru soon shared in the profits from the *cocales*.

Although the Spanish were interested in coca as an item of commerce and coercion to get more gold from the mines, they took no apparent interest in the scientific study of the plants or of the leaves. It remained for the Swiss botanist Joseph de Jussieu to collect the first samples in the early 1700's, two hundred years after the first landings in Peru. Jussieu returned the specimens to the Natural History Museum in Paris, where they were classified by Lamarck, who gave the species its name. Jussieu spent many years collecting in western South America and endured considerable hardship. One of his trips took him to one of the most famous areas of coca cultivation — Coroico, Bolivia — where Rusby was later to study, and where I made observations for this article.

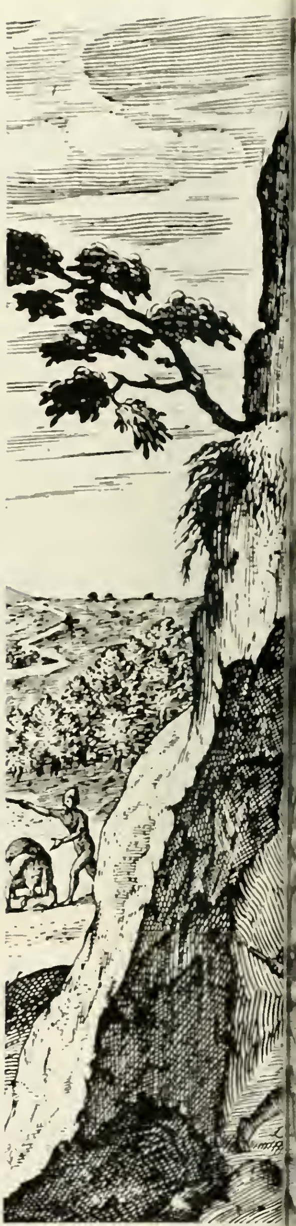
OTHER botanists followed Jussieu, and some made specific studies of coca, its cultivation, and its use. Among these were H. A. Weddell and R. Spruce, who both made contributions to the botanical knowledge of the plants. Chemical studies of the active principals in coca leaves were not made, however, until the middle of the nineteenth century, when scientific interest in plant chemistry began to develop. A. Niemann discovered an alkaloid, cocaine, in coca leaves in 1859. Apparently the first medical application of the extracted substance was made by a German physician, Dr. Carl Koller, when in 1884 he used cocaine in eye surgery.

ACCORDING to analyses made by Rusby in his studies of the leaf, there are several other alkaloids present in the coca leaf that may be more important than the cocaine. Indeed, states Rusby, the Indians prefer leaves that are less "bitter," indicating a lower content of cocaine in some leaves than in others. In spite of these studies, however, knowledge of the effect of the coca leaf as used by the Incas and their descendants in the high altitudes of the Andes is still clouded in ignorance. Several hypotheses on the effect of cocaine in diminishing appetites, in assisting in respiration, and in other pain-reducing effects are available, but there are few supporting experimental works.

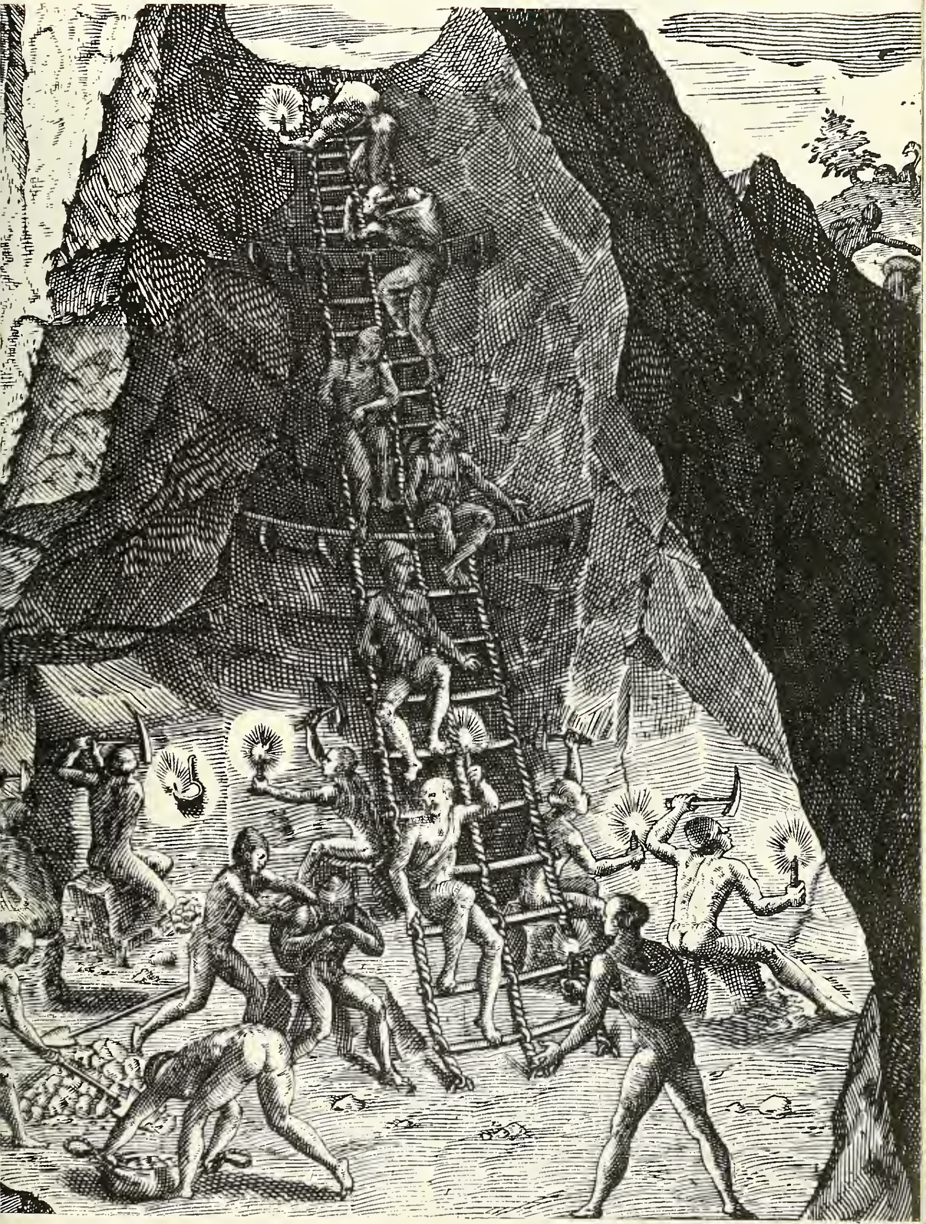
One erroneous idea that persists today is that coca use lowers the mentality of those who chew the leaf. It is difficult to defend this type of statement because it does not take into account the fact that the nutrition of the users is very poor, that they live in an atmosphere of reduced oxygen levels, and that many are forced to labor under the most adverse conditions imaginable. The socio-economic situation of the Indians also plays a role in these matters.

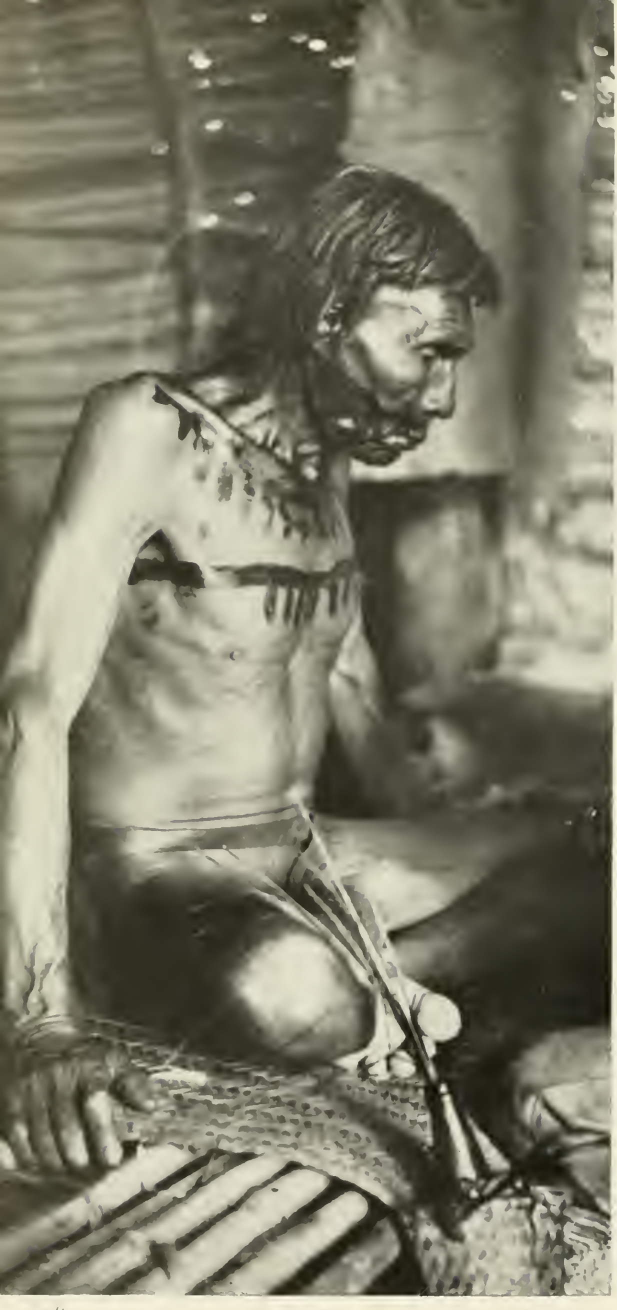
Another possibly erroneous idea is that coca, *as used by the Indians*, is a noxious habit. Though there is little direct evidence that the coca leaf does not produce a habituating effect, several observers have noticed that when Andean Indians move from the high altitudes to lowland areas, they give up coca. This would tend to show that chewing the leaves is not habit forming, but again it must be emphasized that this is tenuous evidence. On the other hand, the positive statement that the use is habit forming is no better supported.

Thus, it is extremely difficult to formulate and carry out sound scientific experiments to determine the real role of coca in the lives of people who find some relief in their "divine" plant.



CONQUISTADORS found that coca use seemed to increase the output of the Incas forced to mine gold in the Andes. An exhaustive study of 60 years ago agrees that chewing coca apparently does aid the Indians in adjusting to heights.





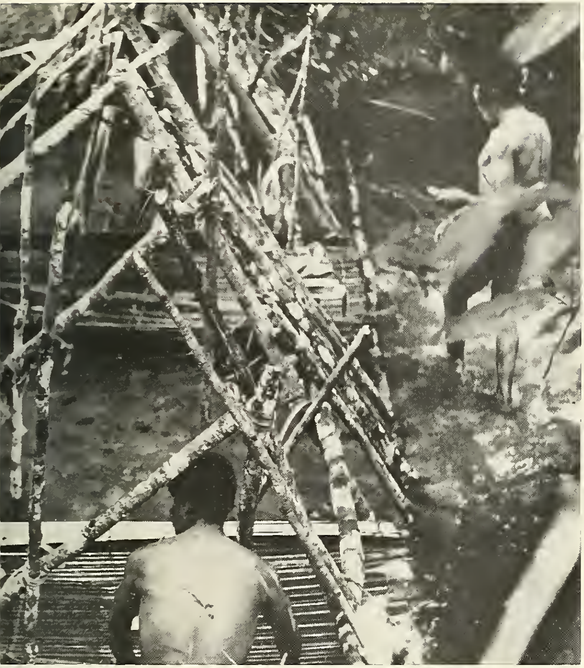
Funerary design painted on a Bororo chief symbolizes the giant armadillo.

Ritual

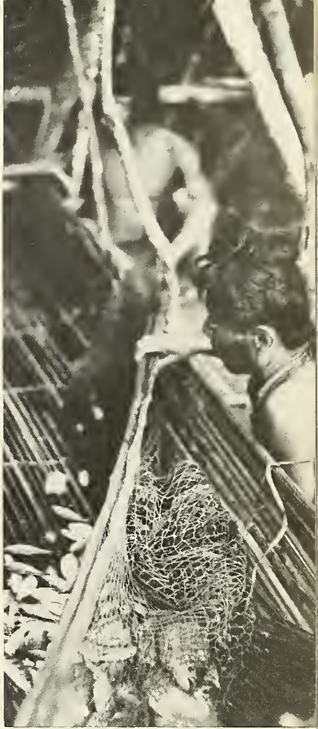
A simple interment

By Vladimír Kozák

Death causes great concern among peoples of all levels of culture. Among primitive peoples, anxiety about death is especially keen because of the widespread belief that the spirit of the dead person may be displeased and may remain in the community to haunt and disturb the survivors. Consequently, it is extremely important to the survivors to dispose of the remains of a dead person in the prescribed manner and to demonstrate their concern for the deceased through the proper rituals. For this reason, the



Weir is built across a stream near the village after a death. Fence is used to trap many fish needed to feed village people during the long funeral rituals.



Drugged fish try to escape weir and are netted when they enter its chutes.

# of a Bororo Funeral

ends full month of highly elaborate ceremony and preparation

ritual practices accompanying death are often among the most elaborate and impressive ceremonies to be found in the primitive world. No more spectacular funerary ceremony is known to ethnology than that of the Bororo Indians of Brazil.

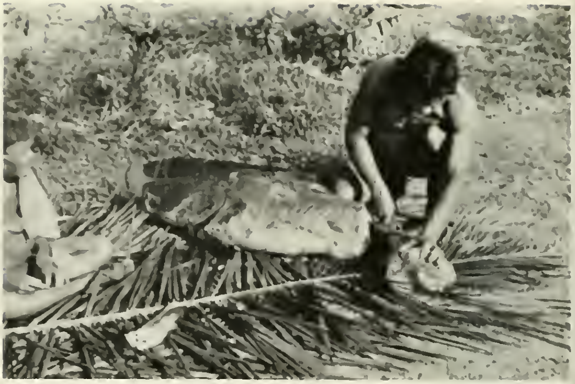
The Bororo now living on the São Lourenço River in the state of Mato Grosso call themselves *Orarimogodogue*—Fish People. Their settlement consists of a number of large thatched houses arranged in a circle around an open dance plaza. Each hut is occupied by a group of closely related women, together with their husbands and children. One special house, larger than the others, is built in the center of the plaza. There the unmarried men sleep, and married men work and perform many of their ceremonies, taking advantage of the seclusion it provides from the women and children. All persons in the Bororo village are divided into two groups, or moieties, membership in which is hereditary. The moieties co-operate in work and compete with each other in recreation.

The Bororo were once among the fiercest tribes of Brazil, and warred against whites and other Indians alike. Today the few villages that remain are pacified and are being affected to an increasing extent by contact with Western civilization. But in much of their ceremonialism these people still retain their native customs.

When a death occurs among the Bororo, all the members of the society put aside the activities of their normal routine for several weeks and together perform some thirty separate rituals that constitute their elaborate and protracted funerary ceremony.

A few years ago, the author, with the co-operation of the Brazilian Indian Service, had an opportunity to visit the Bororo village of Bayamoga

LARGE CATCH is smoked and dried on split-ended sticks set up close to fire.



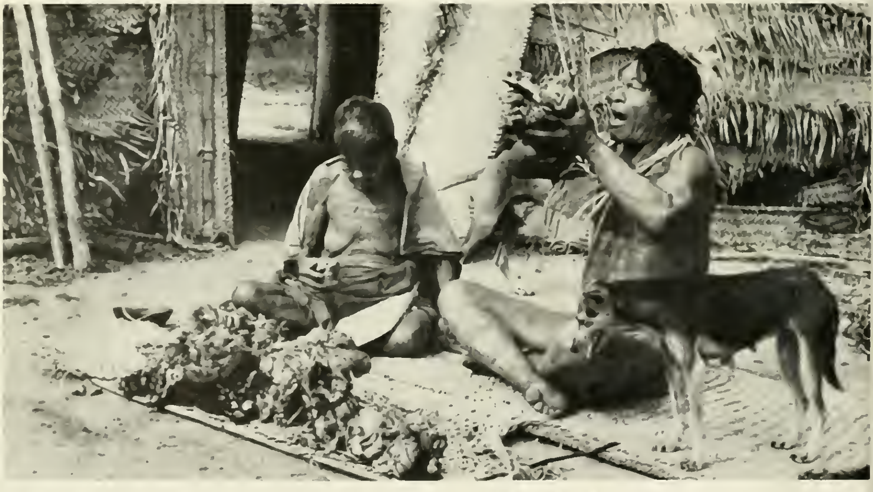
SHAMAN, into whose care all of the caught fish are first given for ritual treatment, here places a large fish on palm leaf and cuts it in small pieces.

on the São Lourenço River, and to photograph the events that followed a death that had just occurred there. This story gives only the highlights of these events—a complete report would require an entire monograph.

When a Bororo is gravely ill, without hope of recovery, his friends and relatives decorate him with feather ornaments and anoint his body with urucú, a brilliant red paint made from the oily seeds of a shrub. As death nears, the assemblage begins to chant softly. Then, one by one they approach the dying person and pay him their last respects by briefly placing a hand on his forehead.

As soon as breathing has stopped, the body is quickly covered with a sleeping mat, for the corpse must not be seen again by the women or children. The mourners, especially the women, wail loudly and further express their grief by cutting themselves so deeply with sharpened mussel shells that their blood runs onto the mat that covers the corpse.

At sundown the body is wrapped in the sleeping mat. If the deceased is a man, his bow and arrows are wrapped with him, and the bundle is taken out to the plaza. All the villagers gather



AFTER BITING FISH, shaman passes it on to his wife, who also bites it. Only then can rest of Bororo eat. The rite is preceded by shaman's hypnotizing himself into a trance, during which he is "possessed" by *Bope*, a powerful spirit.

Mr. Kozák, of Brazil's University of Paraná, has visited many of the Brazilian Indian tribes. This report was prepared in collaboration with **Dr. Robert L. Carneiro**, Assistant Curator of South American Ethnology at The American Museum, and **Dr. Gertrude E. Dole**, a Lecturer in Anthropology, New York University.

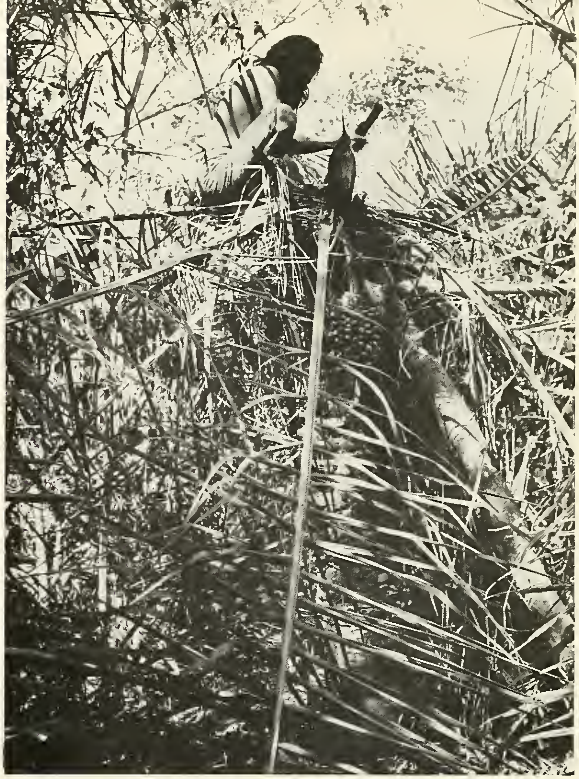
round the corpse and sing funeral songs throughout the night to the accompaniment of the monotonous and rhythmical sound of gourd rattles.

The next morning, while a few young men are busy digging a temporary grave near the men's house, the kin of the deceased gash themselves as before, leaning over the covered corpse so that the blood will flow onto it. Laceration of the arms, head, breasts, and legs is repeated many times during the subsequent weeks of funerary rituals. As another gesture of mourning, the nearest kin tear out some of their hair, while more remote relatives cut their hair short. Thenceforth, the mourners' hair is left uncut until the mourning period of a year or longer is over.

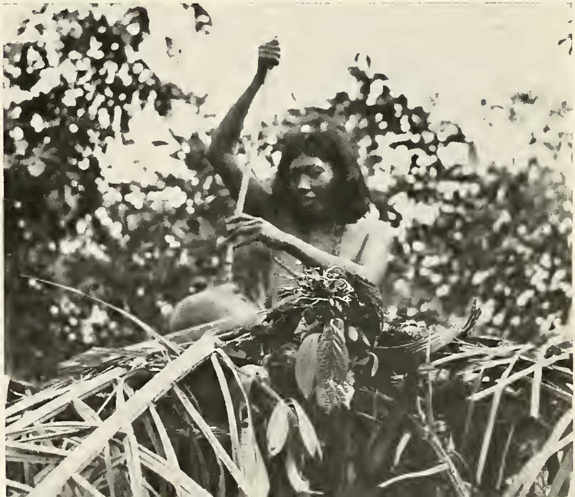
When the temporary grave has been dug in the plaza, the body is interred so that it lies less than a foot below the surface of the ground. At frequent intervals, quantities of water are poured on it to hasten decomposition.

To sustain themselves during the ensuing weeks of exhausting rituals, the Bororo lay in large stores of food. During the early stages of the funerary ceremony the men catch great quantities of fish. A lake near the village supplies them with *jaú*, a huge member of the catfish family, which sometimes attains a weight of 150 pounds and which the Bororo shoot with bows and arrows.

Smaller fish are taken in rivers by drugging them with timbo, a vegetable poison obtained by crushing certain vines. Timbo stupefies or kills fish, but does not affect the quality of the flesh for human consumption. (The active ingredient in timbo is rotenone, now widely used in this country as an insecticide.) For this operation the men build a weir across a stream. The fish try to escape the poisoned water through a chute in the weir. As they pass through, they are caught in large nets, then dried and smoked over a low fire, furnishing several days' food for the entire community.



Woman scrapes well in an *acurí* palm, *above*, after top has been chopped off. Sap seeps upward, and while it collects a leaf covers the cavity. When well is full, *below*, a woman draws off the sap by using a long reed tube as a pipette.



ORNATE BOW, decorated with feathers, is given to outstanding hunter by the relatives of deceased. Hunter must use bow to avenge death by killing jaguar.

WOODEN FLUTES, ornamented with bird down and feathers, figure prominently

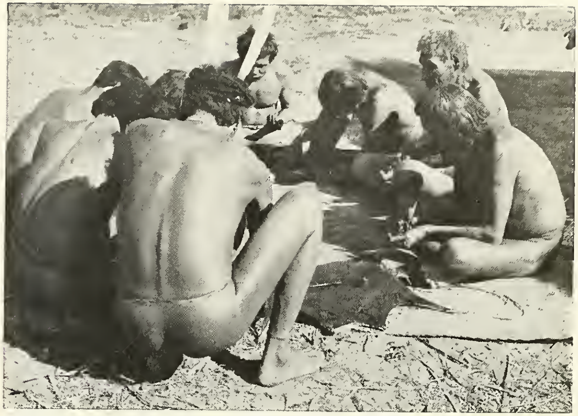
None of the fish may be eaten, however, until ritually treated by the shaman, or medicine man. First, he induces a seizure of trembling, during which he is thought to be possessed by *Bope*, a powerful—and sometimes evil—spirit often invoked by the Bororo to help them locate game and fish. Shaking with the power of his spirit helper, the shaman bites into each piece of fish, thus driving out evil spirits and symbolically consecrating the fish to *Bope* in return for his help in catching it. When this act is completed, the shaman passes the fish to his wife, who also bites it. Only then can other members of the society partake of it.

THE Bororo believe that deaths are also caused by *Bope*. He is identified, in their minds, with the jaguar, and when a death occurs, the Bororo take revenge for their loss by killing a jaguar. This, too, is surrounded with ritual. A few days after a death, the shaman determines where a jaguar can be found by consulting the corpse in its grave. After the corpse has communicated the location of a jaguar, the shaman tells the relatives of the deceased, who then request an outstanding hunter of the opposite moiety to undertake the task of finding and killing the jaguar. To help him in the venture, the bereaved family gives the hunter two presents. The first is a gourd whistle, the sound of which represents the voice of the dead man's soul. The second is a braided cord, made from the mourners' hair, which the hunter wraps around his left wrist to prevent it from being injured by the snap of the bowstring.

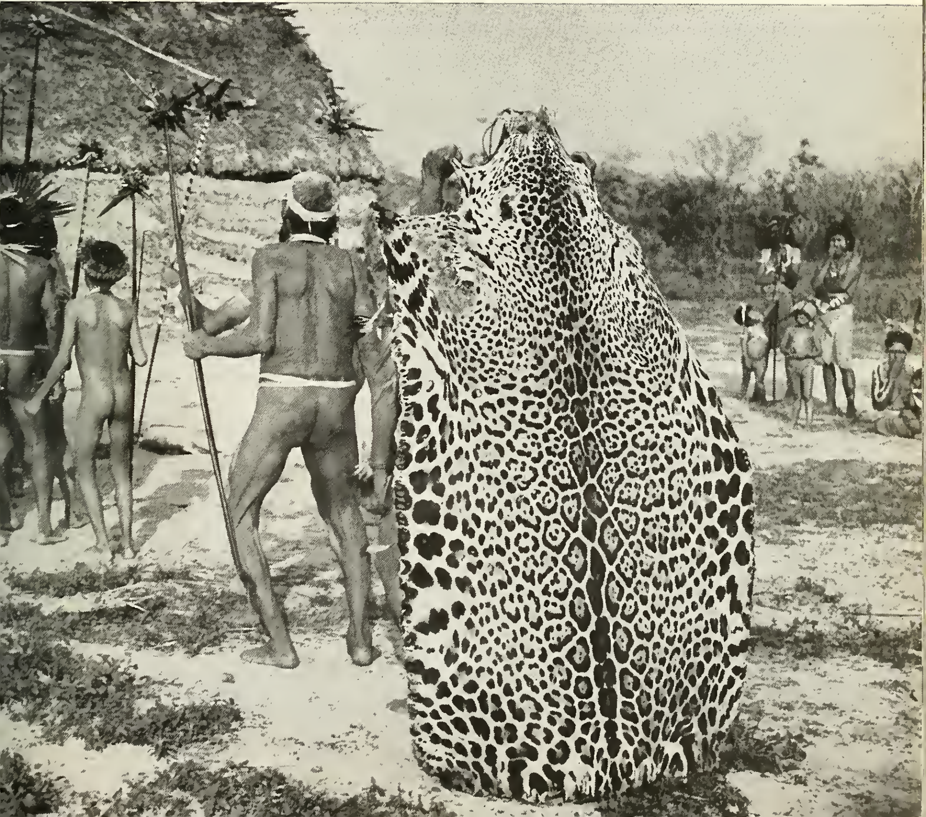
EVEN though the shaman has "learned" the location of a jaguar from the spirit of the deceased, several days may pass before the hunter succeeds in finding one. The ensuing struggle between hunter and hunted is a feat of great daring and skill. As soon as a jaguar comes within shooting range, the hunter releases an arrow. He then immediately lifts his bow into a horizontal position and extends it toward the jaguar, pointing the far tip directly at the beast to parry its attack (a single arrow is seldom lethal). This maneuver must be accomplished with great speed before the jaguar pounces. Enraged by pain, the jaguar leaps at the end of the bow, clawing and biting it. Eye to eye the two struggle, the hunter warding off the beast with his bow held rigidly in both hands. When the jaguar recoils to pounce, the hunter quickly looses a second arrow and again raises the bow to protect himself. When the jaguar finally falls to the ground, weakened by the wounds, a last arrow is shot to end the struggle. If the hunter does not deliver this coup de grâce, he may lose the contest, for the jaguar may still have enough strength to attack when the hunter least expects it.

With the help of a companion, the hunter carries the dead jaguar

n the ceremonies, as do whistles, and rattles and trumpets made from gourds.

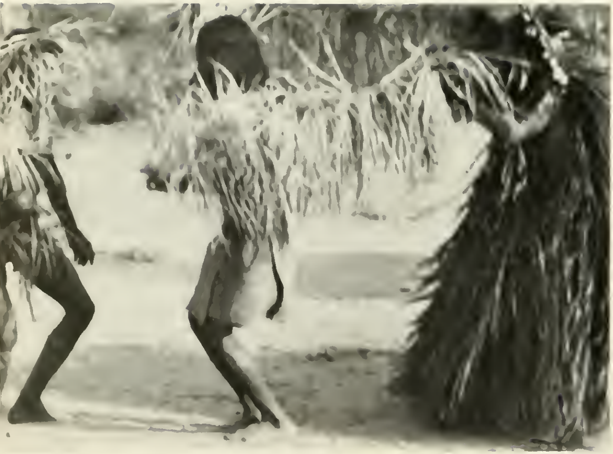


Black designs are painted on inside of jaguar skin, *above*, which is worn by shaman, *below*, in ritual dance to appease spirit of the ceremonial kill.

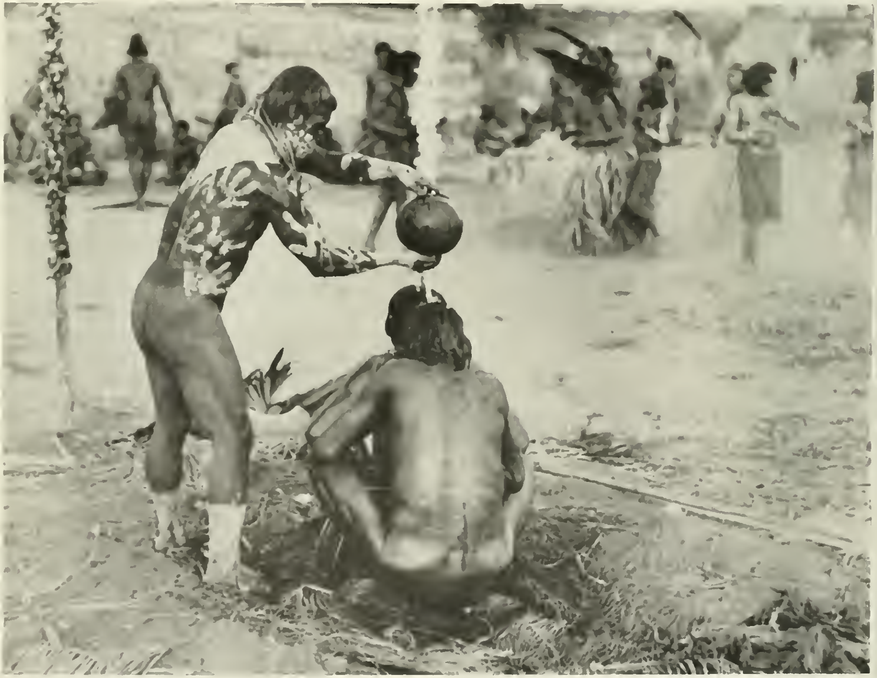


back to the village. Its claws and teeth are pried loose and made into ornaments to be kept as mementos by the close kin of the deceased. The hunter is rewarded with a necklace made of shells and nuts, an elaborately decorated bow, and arrows. The animal is skinned and the inner surface of the pelt is decorated with black paint specially prepared by the shaman. This is presented to the relatives of the deceased in a series of rituals that involve singing and dancing.

The night of the kill, one of the village leaders conducts a dance to the accompaniment of songs addressed to the spirit of the jaguar. With the jaguar hide on his shoulders, a chief or a shaman leads the ritual intended to appease the dead jaguar, while the people of the village dance. Men, women, and children all perform this very important ritual, which continues far into the night. At first many people



MEDICINE MAN, at the left, holds rattle as he leads strenuous dance. Men and women jump, then kneel, to raise and lower palm fronds held between them.



EXHAUSTED DANCERS squat on temporary grave as a friend, daubed with clay to represent a mythical beast, sprinkles them with water. This action cools the dancers and hastens disintegration of body. Feathered pole is a grave marker.

join in the dance, which consists of simple, rhythmical steps or hops. As the dancers become tired, they drop out of line one by one, and eventually the shaman may be left dancing alone.

In preparation for the actual burial festivities, the Bororo ornament themselves elaborately and with meticulous care. They paint their faces and bodies with a variety of fantastic designs in different colors, and may plaster their hair with the red urucú paint. Some wear skirts, capes, and head wreaths made from palm leaves. Hair that was torn out in mourning is spun into cords that are braided and wound around the head in the fashion of a turban. Other striking decorations are chest ornaments made from the claws of the giant armadillo; bird beaks worn as pendants; necklaces of jaguar teeth; chaplets made of a beautiful local flower that resembles our morning glory; and enormous "sunburst crown" feather headdresses, which sometimes incorporate the tail feathers of as many as thirty macaws. These spectacular headdresses are highly prized by the Bororo, because macaws are now scarce in their forests. They will part with one to an outsider only in exchange for a gun.

One of the highlights of the Bororo funeral ceremony is the impersonation of mythical beasts by men dressed in various costumes and performing imitative dances. Two such creatures inspect the corpse about two weeks after its interment in the plaza. Disguised with leaves of the buriti palm, they circle the grave several times. Finally they stop and open it to check the state of the body's decomposition. Their decision is known in advance: the flesh has not yet decayed enough to be removed from the bones. The grave is closed, and the festivities continue.

Another mythical creature is represented by a man whose body is painted white with clay, and who wears feathers in his nose. This beast impersonator runs again and again around the spot where the corpse is buried, trying to call the dead person's soul out of the grave. During this performance, other men in the group shake split bamboo poles, producing a sharp clapping sound.

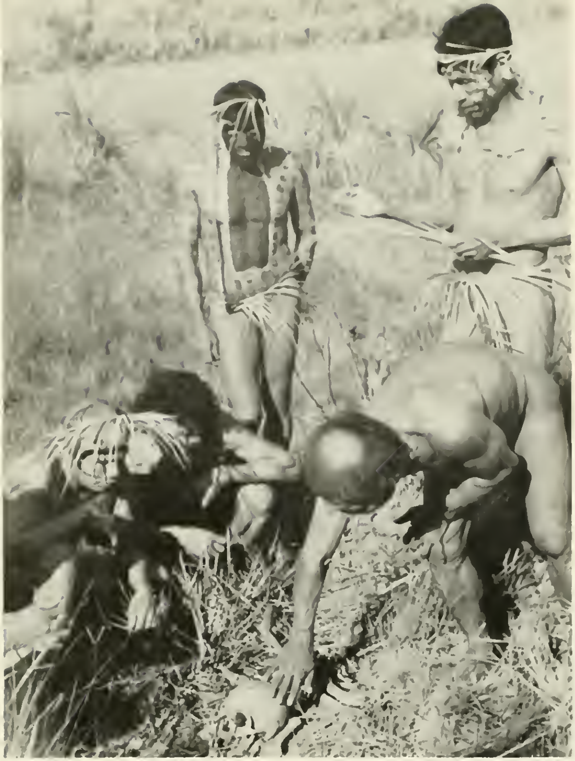
Still another beast impersonator emerges from behind the huts, and rushing across the plaza toward the grave, beats it with a long stick in a renewed effort to call forth the spirit of the dead Bororo.

Palm sap, which has been allowed to ferment slightly, refreshes a dancer who has temporarily dropped out of the ceremony. His headdress is palm frond.

The ritual dances of the Bororo depict in lively and vigorous fashion many aspects of their relations with the spirit world. All the dances take place in the village plaza, and most of them continue for hours at a time, requiring tremendous physical endurance. As one by one the dancers become exhausted, they drop out of line. Weary and covered with perspiration, each one squats unceremoniously on the shallow grave, while someone pours a pot of water over him. These shower baths have a twofold purpose: they refresh the dancers and also moisten the ground, thus hastening decomposition of the body.

Before the dancers return to strenuous activity, they may sip palm "wine." This weakly fermented beverage is prepared from sap of the *acurí* palm, a tree that grows in profusion near the village. To collect the sap, a man climbs to the top of the tree and cuts off the uppermost fronds. Next, his wife ascends and, with a shell, scrapes the pith from the heart of the palm, leaving a deep well in which the sap collects by upward seepage. She covers the opening with leaves, and by the next day the well is full. A number of women then suck the sap into reeds, which they use as pipettes. When a reed is full, they close the top quickly with a thumb and transfer the sap to large pots. It is then taken back to the village and left in the shade for a day to ferment.

For a change of pace from the ritual dances of the funerary ceremony, the Bororo engage in an unusual kind of relay race. Two teams of young men—each team representing one of the two moieties of the society—oppose each other. Men of the two groups cut stems of buriti palms, trim them to a uniform length, and tie them into two huge circular bundles resembling cart wheels. Each one is about three feet in diameter and may weigh more than one hundred pounds. With a "cart wheel" on his shoulder, a lead-off man from each team begins running toward the village. When he tires under his heavy burden, the bundle is taken over



ONLY MEN take part in washing bones in swamp near village. Shaman touches skull in a kind of benediction before all bones are taken back to the plaza.

by a teammate, who, as he in turn tires, is relieved by a fresh teammate, and so on. The race is so exhausting that no rituals are held the next day.

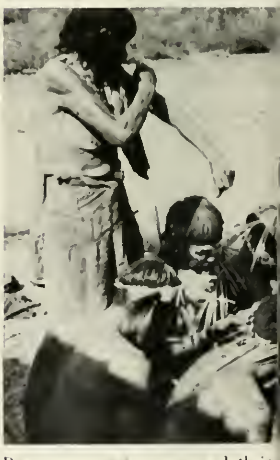
When the rituals are again resumed, they continue with undiminished variety and vitality until the repertory of dances is completed. Then, early one morning, about a month after the initial burial, the skeleton of the deceased, now nearly free of flesh, is disinterred. A few men take the bones to a nearby swamp, wash them without ceremony, and carefully remove all the remaining flesh.

After being washed, the skull is set by a small fire to dry. When thoroughly dry, it is put into a basket with the other bones and carried back to the village, escorted by a procession to the accompaniment of cane flutes and gourd trumpets.

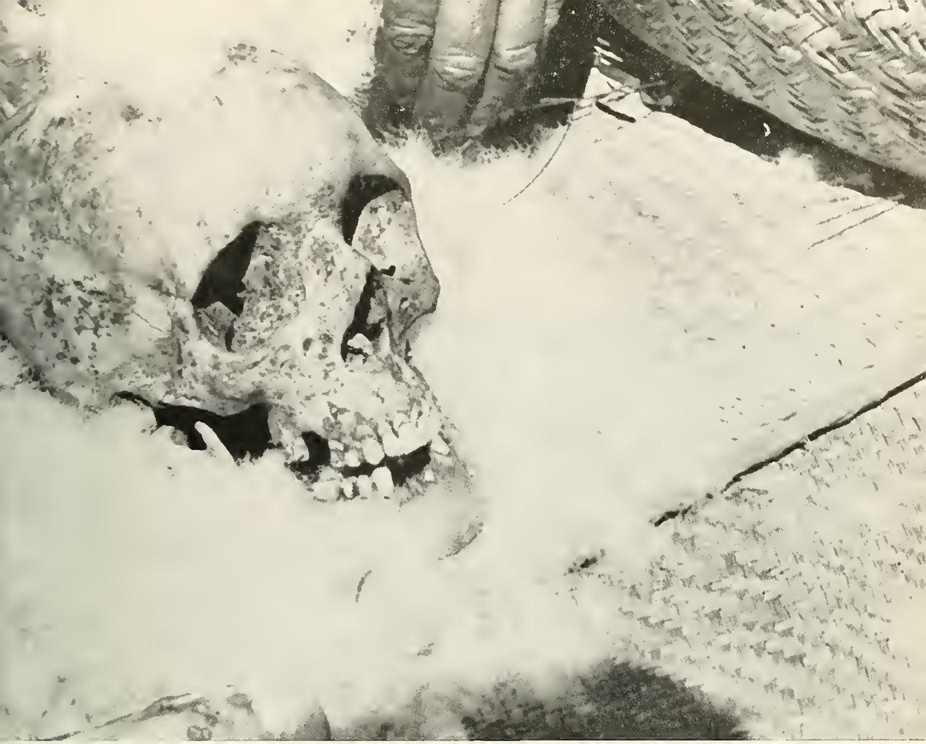
As the procession approaches the village, it is met by the nearest female relative of the deceased, who shoulders the basket and carries it to the men's house. As she sits outside the house, holding the basket in her lap, the other female kin of the deceased once more gash their arms and breasts, and allow their blood to run onto the basket. The men once again shake their gourd rattles and sing the songs and lamentations they intoned at the time of death.

MEANWHILE, several men begin to decorate the skull, which is placed on a newly woven mat resting on the jaguar skin. After smearing it with resin, they press red, blue, yellow, and white feathers on the surface in a traditional pattern. Women may witness the decoration of the skull; in fact, while it is being adorned, they spill the blood from their fresh mourning wounds on it.

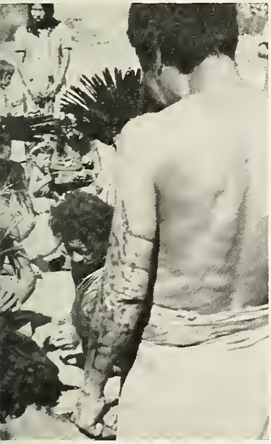
The other bones are decorated with urucú and bands of feathers, and



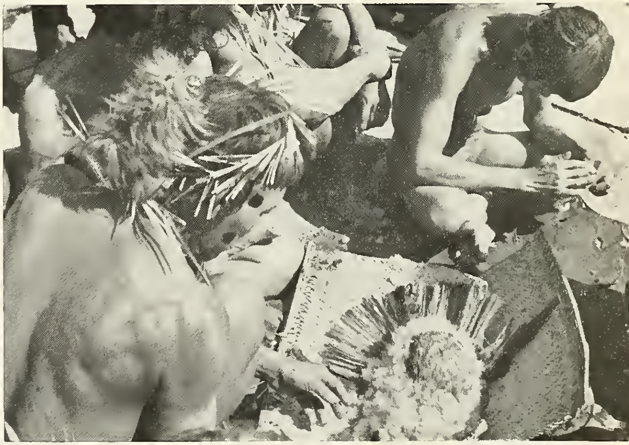
DURING DECORATING, women gash their skin and allow blood to drip on skull.



Cleaned skull is put on a specially woven mat, then men decorate it with feathers. Mussel shell placed on mat is used by mourners to cut their flesh.



Notice cuts on arm of woman at right, whose hair is cropped as mourning sign.



Multicolored feathers, held on with resin, completely cover skull, which is surmounted by feather crown. Still on its mat, skull is put on jaguar skin.

placed in the special basket that is to be their final repository. Then the skull, still resting on its little mat, is placed in the basket on top of the other bones. The edges of the basket are sewed together with a wooden needle and fiber cord, and until its final burial a few days later, it is hung in the house of the deceased's relatives.

ON the day after the bones have been decorated, some of the men go into the forest to carve and decorate a number of bull-roarers. These are flat, fish-shaped pieces of wood, 3 to 4 feet long and 5 to 8 inches wide, which are whirled in the air by means of a long cord. As the piece of wood rotates it causes the cord to twist, and the combined action produces a strange, moaning whir. The rest of that day and all of the following night the bull-roarers are whirled, and their noise is believed to represent the voice of the evil spirit *Bope*. (No woman may see the bull-roarers, for the sight, it is believed, would kill her.) The bones are carried to their final resting

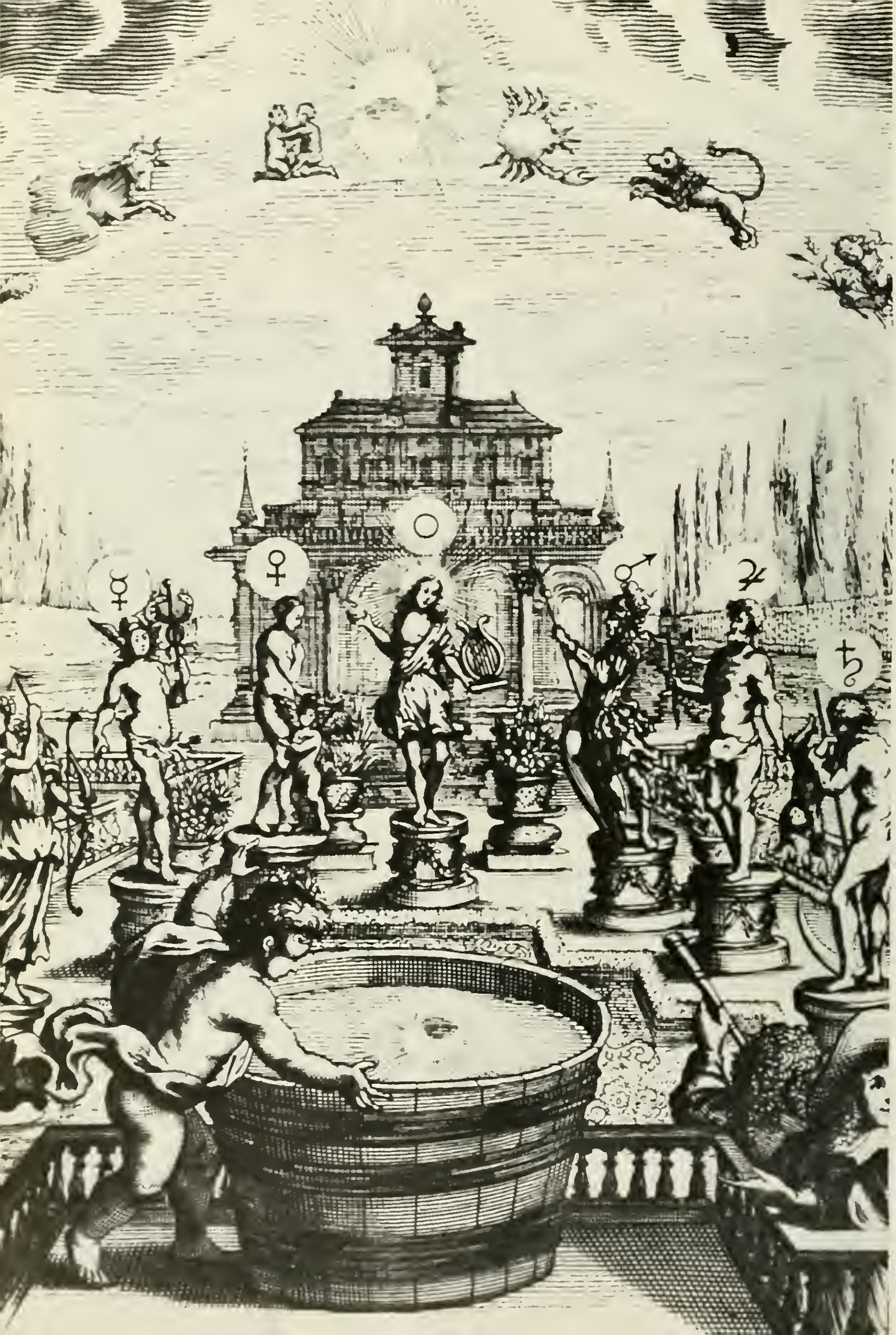
After a month of rituals, the basket containing bones is taken to the swamp and sunk in a deep pit. Man in center

place to the accompaniment of the bull-roarers' whir.

At the swamp, where the final interment of the bones takes place, a deep pit is dug, and the basket is lowered into it. There is no further ritual. Only a long bamboo pole decorated with feathers is left to mark the last resting place of the bones, on the proper disposition of which the Bororo have lavished approximately a month of their time and so much of their energy.

In January, 1958, Marshal Candido M. Rondon, who was a great friend and protector of the Indians of Brazil, and the first director of the Brazilian Indian Service, died. During Rondon's last visit to the Bororo, he spoke in the Bororo tongue with Cadete, an old chief whom he had known for more than sixty years. After a long conversation, Rondon translated for a companion: "He said that I am old and have not long to live, and that I should come here to die, for only the Bororo know how to bury me properly."

is standing in the burial pit, while others in group help him in placement of simple bamboo pole to mark the grave.



SKY REPORTER

Fusion of hydrogen nuclei is the source of the sun's energy

By Simone Daro Gossner

In popular astronomical literature, it is commonplace to point out that the sun is an average star that—were it not for our proximity to it—would be indistinguishable from billions of others. Furthermore. it is quite probable, since the sun is so ordinary, that its family of planets is far from being a unique feature of the universe. If this makes it seem provincial to devote our 1963 series to a survey of the solar system, one should bear in mind that the solar system's components are the only objects of their kind that we can study in detail. Present astronomical instruments are not powerful enough, for example, to detect the existence of planets in other systems, nor can they disclose the surface features of even the nearest star. Only through intensive studies of our own sun and planets can we hope to gain adequate knowledge of the physical conditions that exist elsewhere in the universe.

Until the advent of the telescope in 1609, the sun was believed to be a sphere of pure fire. This concept followed the tradition of the Greek philosophers who spoke of the absolute perfection of everything celestial—a tradition kept alive for centuries by the disciples of Aristotle. To be sure, *sunspots* (dark areas on the sun's surface) are occasionally visible to the naked eye. and had been sighted now and then before 1609. In every instance, however, they were taken for birds in flight or a planet (Mercury or Venus) in transit across the sun's disk.

By the end of 1611, sunspots had been seen telescopically by several independent observers, notably Galileo, Father Christopher Scheiner, S.J., of Ingolstadt, Johann Fabricius, of Wittenberg. and Thomas Harriot, of England. Galileo assumed rightly that sunspots were features of the solar surface and used his observations to prove that the sun rotates on an axis. By an ingenious bit of reasoning he also deduced that the spots must be brighter than the full moon and are dark only by contrast with the rest of the solar surface. This was confirmed by modern measurements.

Early observations of sunspots were only the first step in the elaborate series of solar studies that spanned the next 350 years. No other celestial body has been submitted to a greater number of observing techniques. The variety of instruments used for this purpose has no match in any other field of astronomy. Entire observatories have been built for the sole purpose of studying the sun, and countless astronomers specialize in this single subject. The external features of the sun, either permanent or transient, are known in minute detail. The constitution of the solar interior, on the other hand, can only be surmised from theoretical considerations. Any explanation of the external features must also be based on theory. But the steady progress being made in atomic and nuclear physics is contributing much to our understanding of solar processes.

Allegory of solar system comes from Erasmus Francisci's *Eröffnete Lust-Haus*, Nuremberg, 1676. At top, symbols of zodiac flank partial eclipse of sun. Statues depict, from the left: moon, Mercury, Venus, sun, Mars, Jupiter, Saturn.

The surface of the sun as we see it with the naked eye is called the *photosphere* (sphere of light). Its diameter is about 864,000 miles, or nearly 110 times the earth's diameter. Surprisingly, it is the sun's deepest region that is accessible to observation, and not the outermost, as common sense would suggest. The photosphere is completely encased in a thin layer, some 10,000 miles high, known as the *chromosphere* (sphere of color). Fainter and much less dense than the sun's main body, it may be considered a lower atmosphere. The chromosphere is normally lost in the sun's glare, but during total eclipses it appears as a narrow, red ring around the obscured sun. The outer atmosphere, or *corona*, is so thin that it is actually emptier than the most complete laboratory vacuum. Its shape and dimensions vary periodically, but it is known to extend several million miles from the sun's center. The corona is also too faint to be seen except during eclipses, but its brighter parts may be observed with a special telescope—the coronagraph—in which an artificial eclipse is created by inserting a metal disk in the instrument's focal plane.

The photosphere, the temperature of which is of the order of 10.000°F., is the site of the well-known sunspots, which seem dark by contrast because their temperature is a relatively cool 7000°F. Sunspots are sporadic features related to the sun's magnetic field. They are often associated with the appearance of *prominences*, enormous looped arches of gas that gradually expand into the corona.

Like most other stars, the sun is composed principally of hydrogen, a fair amount of helium, and a sprinkling of other elements. It does not generate heat by burning (in the sense that a log burns in the fireplace), but rather by the nuclear fusion of hydrogen to produce helium. This process, in which four hydrogen nuclei are transformed into a nucleus of helium (see Natural History, March, 1960), is similar to the reactions that take place in a hydrogen bomb. Because the helium nucleus is somewhat less massive than the four hydrogen nuclei, the mass lost in their fusion is transformed into energy, as predicted by Einstein's equation $E=mc^2$. The energy, in turn, is eventually radiated into space. The helium that is produced in this reaction is an inert ash that remains in the sun as part of an extremely dense core.

It is currently believed that the sun has been producing energy in this orderly manner for the past five billion years. Astronomers estimate that the amount of hydrogen the sun contains is sufficient to keep the same processes going for another five billion years. By then, however, the hydrogen content will drop below a critical level. Other nuclear reactions will begin in the core. The sun will expand, and most conservative estimates indicate that it will swell to approximately twenty times its present radius (a quarter of the way to Mercury). For a while it will use up its energy in spendthrift fashion. Then it will begin to shrink to a mere fraction of its original size. A dying star, the sun will cool off gradually and will fade into oblivion.

THE SKY IN JANUARY

From the Almanac:

First Quarter	January 2, 8:02 P.M., EST
Full Moon	January 9, 6:08 P.M., EST
Last Quarter	January 17, 3:35 P.M., EST
New Moon	January 25, 8:42 A.M., EST

In 1963, earth will be closest to the sun on January 4.

For the usual observer:

Mercury will be at its greatest eastern elongation on January 4. It will be in the evening sky until January 20, setting 90 minutes after the sun January 1 and one hour after on January 15. At inferior conjunction January 20, it will enter the morning sky on that date. By the end of the month it will rise 90 minutes before the sun and may be found low in the southeastern sky at dawn. In general, the planet will be too close to the sun for viewing except for a few days at the beginning and end of the month.

Venus, in the morning sky (−1.2 magnitude), will be at its greatest western elongation on January 22 and should be a conspicuous object throughout the month. It will rise three and one-half hours before the sun on January 1, three and one-quarter hours before on January 15, and three hours before on January 31.

Mars, in Leo (−0.7 magnitude at midmonth), will rise in the northeast two and one-half hours after sunset on January 1, one and one-half hours after on January 15, and at sunset on January 31, and will pass nearly overhead in the course of the night. The planet will approach opposition and will brighten perceptibly. Its distance from earth will decrease from 73 million miles on January 1 to about 62 million miles at the end of the month.

Jupiter, in Aquarius (−1.7 magnitude), will be found in the southwestern sky at dusk. It will set in the west at 10:00 P.M., local time, on January 1, 9:00 P.M. on January 15, and at 8:00 P.M. on January 31.

Saturn, in Capricornus (+0.9 magnitude), will be very low in the southwest after sunset, setting at 7:15 P.M. on January 1, and 6:15 P.M. on January 15. After that date, the planet will be too close to the sun for observation.

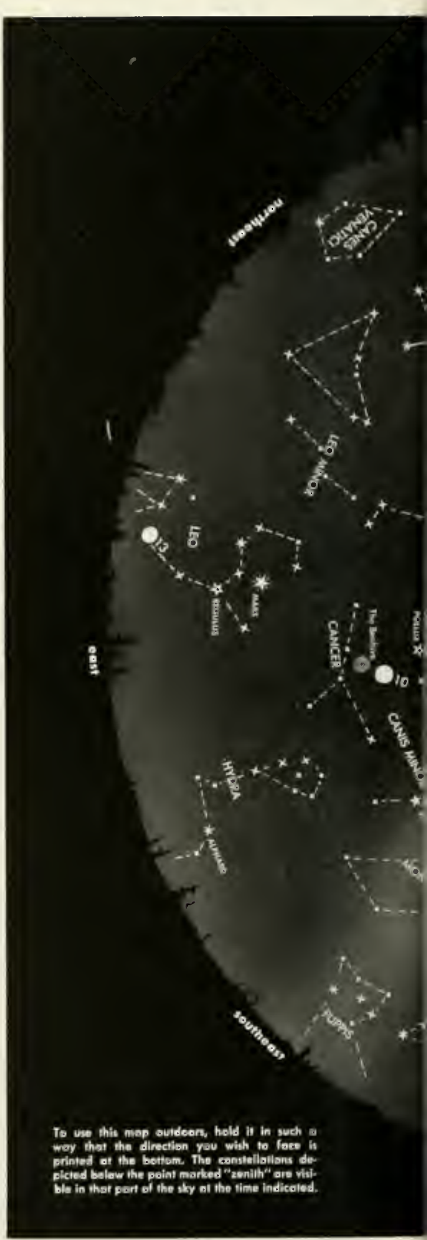
A brief meteor shower, the Quadrantids, may be expected on January 3, with a maximum rate (for a single observer) of forty-five meteors per hour.

Eclipses:

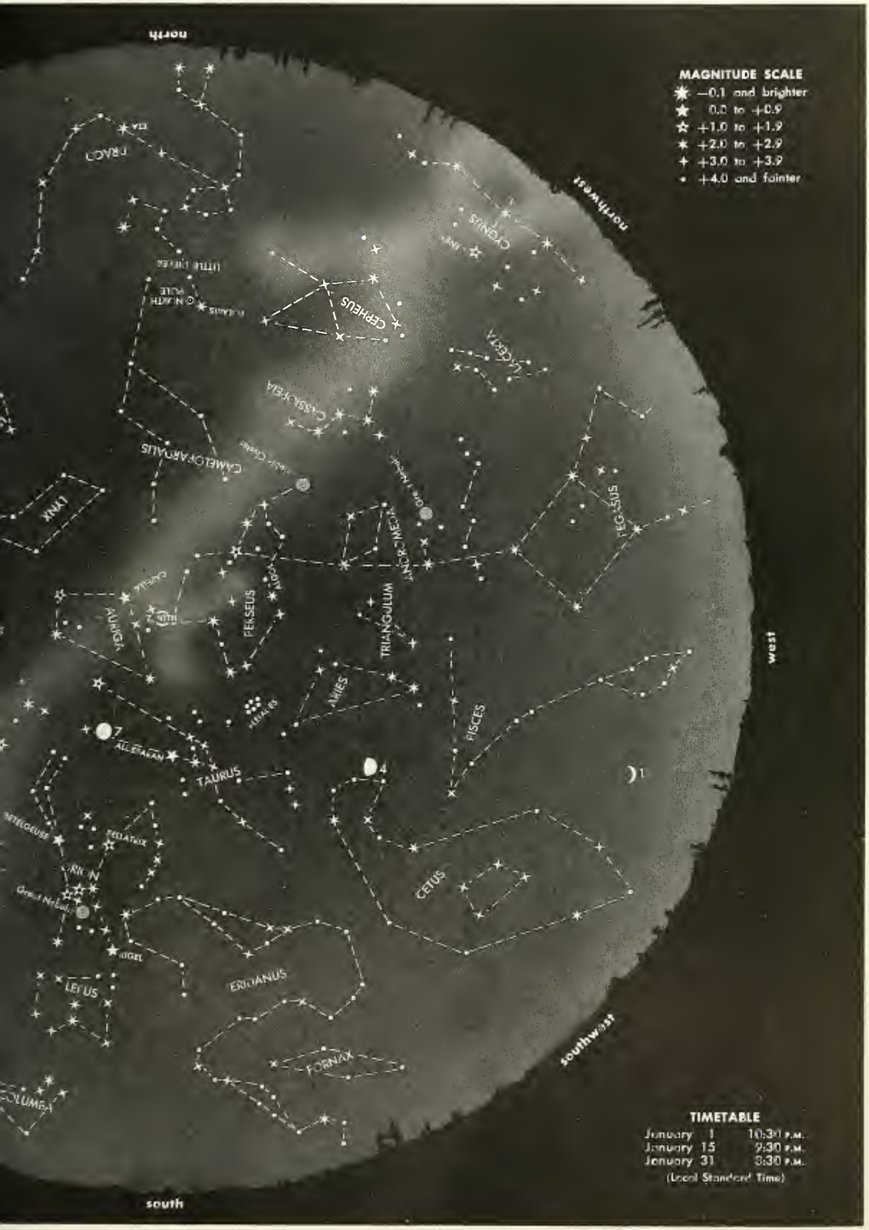
A penumbral eclipse of the moon will occur on January 9. In such an eclipse only a slight dimming of the lunar disk is noticeable, without any sharp contacts. In the United States, the moon will rise while the phenomenon is already in progress. The eclipse will end at 8:34 P.M., EST.

An annular eclipse of the sun, on January 25, will be confined almost entirely to the Southern Hemisphere. The path of the annular phase will start at sunrise in the Pacific Ocean, west of southernmost South America. After crossing Chile and Argentina, it will proceed across the Atlantic Ocean to the Cape of Good Hope. Barely touching the southern tip of the Republic of South Africa, it will then cross Madagascar and end at sunset in the Indian Ocean. The duration of the annular phase at any one place will be brief, usually less than a minute. Varying amounts of the partial phase will be visible from the southern half of South America, south and central Africa, and most of Antarctica.

On these pages, MRS. GOSSNER presents the first in her 1963 series—a co-ordinated review of the solar system.



To use this map outdoors, hold it in such a way that the direction you wish to face is printed at the bottom. The constellations depicted below the point marked "zenith" are visible in that part of the sky at the time indicated.


north
DRACO
LITTLE DIPPER
NORTH POLE
POLARIS
CEPHEUS
CYGNUS
DENEB
LACERTA
CASSIOPEIA
CAMELOPARDALIS
Double Cluster
LYNX
Great Nebula
ANDROMEDA
PEGASUS
CAPELLA
AURIGA
PERSEUS
ALGOL
TRIANGULUM
ARIES
PLEIADES
PISCES
7
ALDEBARAN
TAURUS
4
1
BETELGEUSE
BELLATRIX
ORION
Great Nebula
RIGEL
CETUS
LEPUS
ERIDANUS
FORNAX
COLUMBA
northwest
west
southwest
south

MAGNITUDE SCALE

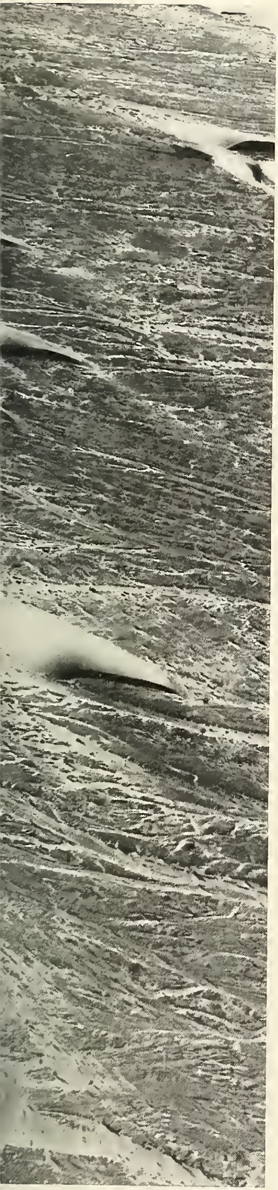
- −0.1 and brighter
- 0.0 to +0.9
- +1.0 to +1.9
- +2.0 to +2.9
- +3.0 to +3.9
- +4.0 and fainter

TIMETABLE

January 1	10:30 P.M.
January 15	9:30 P.M.
January 31	8:30 P.M.

(Local Standard Time)

Barkhan dunes, carrying sand lizard populations, move several feet each month toward their cusps, or peaks, on ancient lake bed in south California.



Environment and a Lizard

Desert history is clue to adaptations

By Kenneth S. Norris

The American desert in 120° F. of noontime heat can test any creature's endurance. Around the edges of desert valleys one sometimes finds patches of palms tucked in the hills where underground water rises to the surface. As the temperature rises, animals of all kinds seek the shade. Birds and bats are sheltered by the fronds and coyotes bed down in the reeds.

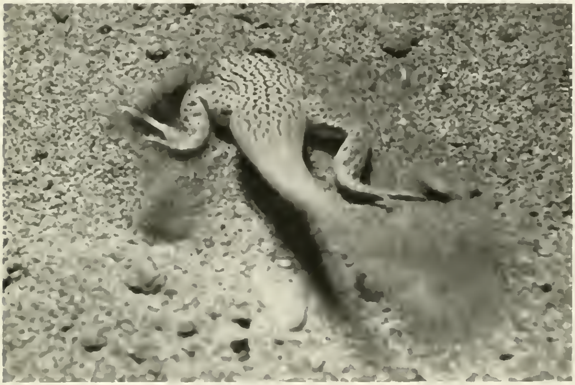
Yet most desert animals live their entire lives on the rocky bajadas, among the brown boulders of parched desert canyons, or on the sandy floor of the desert itself, far from palms and water. They survive because they avoid the desert's extremes in one way or another. Desert rattlesnakes, for instance, will die in minutes if forced to stay out in the noonday sun; they are largely nocturnal, and will seldom venture abroad until the scorching sand has cooled. This solution to environmental rigors is used by hundreds of species, and the desert teems with life after the sun sets. Many animals, however, must be active during the day, facing the desert and somehow surviving it at its worst. One such creature is *Uma*, the fringe-toed sand lizard. *Uma* thrives during the day in perhaps the most rigorous environment of all—the sand dunes.

In addition to extreme heat and shifting sand there are violent winds that may suddenly whip the still sand into blinding, swiftly moving sheets that sweep up windward slopes and cascade in long plumes into the lee.

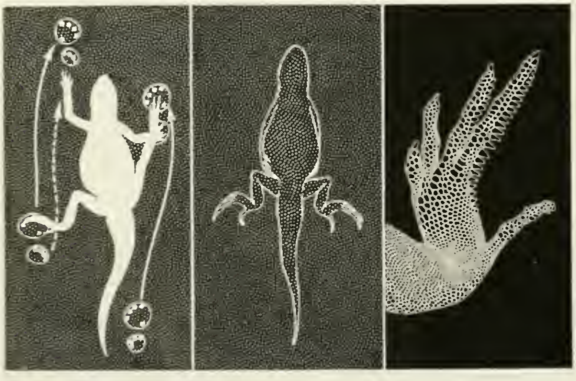
The lizards meet these problems with a number of adaptations. First, the heat is simply avoided. The lizards do not venture abroad except on balmy spring and fall days or during the early

Lizard's spotted body, which may be 3 inches long, blends with sand color.

ADAPTATIONS protect lizard from sand. Eyes are equipped with mechanism that permits ejection of the grains; nostrils have valves that stop any infiltration.



QUICK "DIVE" is followed by swimming action, *above*, that enables lizard to burrow several inches under surface of a dune away from heat and predators.



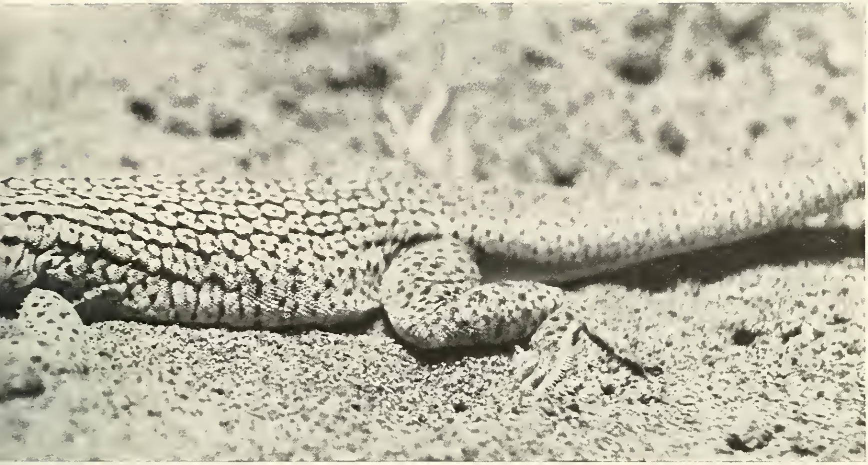
ALL FOUR LIMBS propel *Uma* over dune, *left*, but forelegs are appressed when lizard pushes under sand. Fringes on hind toes, *right*, facilitate locomotion.

morning hours in summer. An occasional individual may be active on the warmest winter days, but none is to be found in the midday summer heat. All are buried in cool sand only inches below the surface. They plunge headfirst into the dunes and burrow out of sight when heat or sandstorms become intense or predators threaten. Burrowing is done so rapidly that it has been termed "sand swimming."

Just as a man uses snowshoes to enable him to move more easily, sand lizards use a series of elongate valvular scales, or "fringes," that border their toes and give them their common name. The scales enable them to attain the remarkable speed of 15 miles per hour over the dunes.

FLYING sand poses no real problem, for with the first onslaught the animal turns its tail into the wind and the grains cascade over its sleek back, perhaps even burying it. If sand gets into the lizard's eyes a few blinks gather the grains into a pellet that is flicked out with one of the long hind toes, or popped out by a special mechanism within the nictitating membrane of the eye. The lizard's nostrils are protected from infiltering sand by a pair of efficient valves.

Sand lizards have long been known to occur in the harshest parts of the North American deserts, from the



Lizard at rest has lifted its tail and toes off sand's hot surface. This and other photos show *Uma notata notata,* one of four North American species.

southern reaches of Death Valley to he barren shores of the northern Gulf of California. Rather recently, however, two odd and primitive forms of *Uma* were found living in remote parts of the Chihuahuan desert of central Mexico. It seems inconceivable that dunes were once continuous, even in-ermittently, over the hundreds of miles of mountainous and forested and that now separate these two North American deserts. There is no geologic evidence for such a connection.

No fossil *Uma* has ever been found, so any explanation of the origin of hese two population centers must be based upon knowledge of desert his-ory and of the morphology and behavior of the *Uma* itself.

The first clue to the history of the genus comes from the habits of modern sand lizards. Each day *Uma* emerges and retreats from the sand n rigid correspondence to its particular immediate environment. Temperature fluctuations during a typical day are wide, and extreme habitat tempera-ures range from 0° to 189° F., but hrough its movements *Uma* secures a moderate climate. The lizard is active at a body temperature of from 95° o 105° F.

This selected environment is geared o intermittent rainfall, or to almost none at all. It is without extremes, except of aridity. Observations of other reptile species suggest that all survive in various environments, each of which is far different from the present desert climate as a whole. Furthermore, two major classes of such special environments appear to be sought by desert lizards; one is the arid-warm type of the sand lizard and many other lowland species, and the other is a moist-cool type of many species now found on the crest of desert mountains. These two major divisions of desert reptile fauna originated, in all probability, with the deserts themselves. To understand them we must go back into the geologic past.

The first trace of aridity is found in fossils of small, resinous-leaved plants in rocks of Eocene age laid down some 50 million years ago in what is now Wyoming. The climate suggested by these fossils is far from what we call desert, but they indicate that semiarid conditions may have started that long ago, gradually spreading and becoming more intense during the following epochs.

True deserts are so new, however, that the majority of the lizard's development must have taken place under the influence of climates different from those of today's deserts. It is reasonable to assume, therefore, that the species and the deserts in which they lived evolved together.

No one knows what the sand lizard's ancestors looked like in the early periods, or where they lived. However, they may have begun their adjustment to arid conditions somewhere in the southwestern United States and northern Mexico—the area that is now desert or arid subtropical scrub forest.

Aridity increased during the Miocene epoch, which began about 25 million years after the earliest indications of dryness, but was as yet far from being of desert intensity. Most important, vegetation over this region differentiated into two well-defined floras. One, the Arcto-Tertiary flora, has its present counterpart in the temperate forests of North America and Asia. It comprised pines, alders, beeches, spruces, redwoods, gooseberries, and similar plants, and during the Miocene spread across North America in a broad belt, ending at what is now the southern limit of the Great Basin region. Most of the reptiles of today's moist, cool, desert mountain peaks moved and evolved with this flora.

To the south an entirely different assemblage—the Madro-Tertiary flora appeared. Its plants were small-leaved, drought-resistant species, including live oaks, grasses, thorn-forest elements, and chaparral species. Some of the animals and plants associated with this early flora were destined to seg-

Assistant Professor of Zoology at U.C.L.A., Dr. Norris does research on the evolution of desert reptiles and on the reaction of cold-blooded vertebrates to environmental stimuli.

regate and to occupy the deserts when these reached their modern expression. A *Uma*-like lizard was very likely among these pioneer organisms.

This dichotomy of a moist-cool and a warm-arid fauna and flora has persisted. Today, the warm-arid group is in ascendancy in the deserts, while the moist-cool biota persists only on mountaintops and around northern fringes of the deserts.

Even today it seems likely that in their avoidance of climatic extremes, *Uma* and many other reptiles are in effect "selecting" an environment much like the generalized Madro-Tertiary one their ancestors knew in pre-Ice Age times. We can speculate that the primordial *Uma* was distributed widely through lowland areas of the moderately arid Madro-Tertiary flora, and that its population was split into two major parts by the lava flows of the Mexican Sierras, leaving one segment to occupy central Mexico where the Chihuahuan desert would one day develop, and the other to exist in the regions west of the mountain chain.

This prototype of *Uma* was probably not yet locked to life on dune sand, for careful inspection of adaptations in the two central Mexican species and comparison of these with the two west coastal species shows that each geographical group is essentially different. For example, while all four species possess elongate scales on the toes, these "sand shoes" are different in each group of species, and probably arose separately as the two deserts developed separately. Similarities in the two groups of lizards also seem to stem from ancient times before they were specialized for sand living.

It is probable that major desert dune masses did not develop until the middle of the following epoch—the Pliocene. By Middle Pliocene time, mountains had risen along the borders of the unborn deserts, sharply increasing the aridity. Grasslands spread over great areas. In the most arid localities bare soil and intermittent streams must have combined to develop dune sand. This demanding new habitat was probably populated by animals, including lizards, that were used to life along sandy stream-courses or on barren sand flats. Old adaptations, such as those that permitted burrowing at night and protection from dust storms, became modified and refined into the exquisite behavior and anatomical structures of the modern sand lizard.

The close of the Pliocene epoch, about a million years ago, was marked by the onset of continental glaciation. Great ice sheets of the Pleistocene did not invade areas that are now desert. Instead, the ice forced storms southward beyond the edges of the glaciers and over the present desert areas. Rainfall increased, and at the same time cloud-cover reduced evaporation, permitting vast inland lakes to accumulate in the northern Great Basin area, while harsh winds blowing off the ice induced "sympathetic glaciation" on several higher southern peaks.

Then the climatic cycle swung the other way. Glaciers melted back and aridity increased. True deserts appeared for the first time and desert animals must have responded by invasion of the new arid areas. Four times the ice advanced and retreated, and four times the new desert communities must have expanded and contracted.

Because the Pleistocene epoch was so short and encompassed so many events, its history is uncommonly tangled, and the history of the sand lizard is obscure for five-sixths of the time. Only for the 17,000 years or so since the last great ice sheet began to retreat has a record been left, allowing the story to be pieced together.

Modern sand lizards never leave the dunes and must move with them. So, since the animals occur over much of the present western desert on individual isolated sand deposits, we must assume that the sand dunes themselves have been in a state of flux since the last advance of the ice. Winds sweeping down intermittent desert stream-courses winnow sand from the dry beds and pile it against banks, forming corridors along which the sand lizard has moved. In some places sand has been blasted against the faces of mountains or into divides, choking canyons and burying vegetation. Once again, as in previous times of retreating ice, the lizard has moved along the mountain passes and entered drainage courses.

A broad view of this reinvasion process suggests that the sand lizards withdrew into the great dune tracts of southeastern California and northwestern Sonora during the ice maxima. With the retreat of ice, the creatures re-entered the Mojave Desert, possibly along the borders of the Colorado River, and spread up two major drainages along stream-edge dunes and across low divides. They made their way to the Amargosa

Sculptured dunes in the vicinity of Death Valley's southern tip represent northern limit of lizard's penetration.

River, which enters Death Valley, but were unable to cross the formidable barrier of glittering salt flats that fill the valley floor. The extensive dunes at the north end of Death Valley remain unoccupied. Members of the genus invading the Mojave Desert probably moved on the most precar-ous and fleeting of paths. Tiny popu-ations may have crept along stream banks as winds shifted and moved little bank-edge dunes along, a few hundred yards at a time. Perhaps only a handful of individuals successfully crossed some parts of the path. Little pockets of sand in valleys along the edges of these major paths sometimes harbor populations of sand lizards.

Many of the now-isolated populations along these old routes differ slightly from one another. These differences, which may have been produced by the chance that the invaders were slightly dissimilar from the total originating population, and the short space of geologic time that has passed since the invasion began, together suggest that the lizards arrived in the area in small groups.

Uma is a product of the events that produced the deserts. Sand lizards adapted through long ages, and made their way across remarkably long distances of desert terrain as climates changed. Today, that adaptability allows them to survive as the vagaries of desert winds force the dunes they occupy into ever-changing locations.

what's the Occasion?

birthday

anniversary

promotion

housewarming

thank you

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J-63

NATURE and the CAMERA

Choosing equipment for use in the field

By David Linton

As urban areas spread deeper into surrounding countrysides, the nature photographer has to go farther and farther afield to find nature subjects. Various small creatures can often be seen in a city park, but larger forms of life must usually be sought far from built-up areas.

Leaving behind highways and power lines not only restores the soul, but also provides the sole opportunity for many kinds of nature photography. And a subject that is far from "civilization" does not preclude effective photography. Rather, a long photographic field trip is a good antidote for the exaggerated belief in great quantities of equipment that is chronic among photography fans and even infects some professionals.

In the far woods, deserts, and mountains, he who carries the least can go the farthest and may come back with the most and best pictures. One develops an attitude that is at once ascetic and practical when he is carrying everything on his back. Back packers do not ask "What can I take?" but "What can I leave out?" They disdain any item that can be used for only one purpose, and anything that remains unused by the end of a trip will be left behind the next time. Their simple, effective discipline could be an example to most photographers.

Many of the best natural subjects are in places accessible only on foot, on horseback, by dogsled, or canoe. To photograph them successfully, equipment must be rigorously selected for maximum utility combined with minimum weight and bulk. The Appalachian Trail Conference suggests a maximum load for extended hiking of 35 pounds for a man and 30 pounds for a woman. Pay load for a burro is 100 pounds, and for a canoe about 200 pounds in addition to the paddlers (but canoe loads become hiking loads when a portage is reached).

Minimum personal equipment—sleeping bag, clothing, food and cooking utensils, and a pack in which to carry them—will weigh about 30 pounds per person if wisely chosen, more if the traveler is inexperienced. An ordinary gadget

Taylor Valley, in Antarctica, is the site of this field camp, sixty miles from McMurdo Sound. Successful photography bag with two small cameras, several lenses, film, filters, accessories, and a small flash unit weighs about 20 pounds. If the photographer wants to arrive sufficiently fresh to take pictures, he would be wise to keep his load well below the maximum, so simple arithmetic indicates that something will have to be eliminated if he is not to be limited to day trips.

Reducing the equipment load is both possible and good discipline. It teaches one to use the head instead of the back. At home one may use one camera for color and another for black and white; n the field a single camera must serve, vith film being changed as needed.

A camera for mobile field photography should be sturdy, adaptable, compact, and light. The necessary accessories and ilm supply must also meet these requirenents. This eliminates all cameras that use sheet film, because they require film holders (an adequate number of which nay weigh as much as the camera) and a changing bag in which the holders can be reloaded.

On all counts, the 35 mm. camera is he best choice for this type of work. t will make 576 exposures on a pound of film, and is the lightest practical type. The "subminiature" cameras that use ilm less than 35 mm. wide are not yet ufficiently well developed to compete vith the 35 mm. camera. Among 35 mm. cameras, the older and simpler models are better for field use than many new ones. As cameras have become more nodern they have become heavier, and the added weight may contribute nothing to the effectiveness of the mechanism. Cameras with bellows are not as sturdy as those with solid lens mountings, and are not good choices because their lenses are not interchangeable.

If much of the photography is to be close-up or long-lens work, a single-lens reflex camera would be best. The rangefinder camera, however, is lighter and is better for work at medium distances. In either case, extension tubes should be carried if any close-ups are planned. The tubes are more satisfactory than either auxiliary lenses or extension bellows.

Many of the older rangefinder 35 mm. cameras had lenses that, with a quarter-turn to unlock them, could be collapsed into the body of the camera. These collapsible-mount lenses are relatively slow (f/3.5 to f/2); but many are of excellent quality, and larger apertures are rarely used in the field. Since many such lenses are now out of production and out of fashion, prices for used collapsible lenses tend to be low.

CAMERAS of older vintage may be good choices if they are not too worn mechanically. Besides being lighter than current models, they are usually more compact. An exception to this rule is the single-lens reflex, which did not come into its own until a few years ago.

It is worth considering the purchase of a special camera—simple, sturdy, and light—exclusively for field work. Alternatively, one could use the same

t such camps necessitates careful selection of equipment. The photographer must place a premium on its versatility.

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camera body for everything, but with a lighter, collapsible-mount lens for use in the field. With this lens attached, the camera would fit a smaller case.

There are even a few long-focus lenses with collapsible mounts. They are sometimes available in secondhand camera stores. Lenses do not wear out (although they can be damaged) and old ones may be perfectly good. They must be adjusted to focus properly on the camera with which they will be used. The camera repair technician who does the adjusting would be likely to uncover any serious defect in the lens. The checking and adjusting should be done during the "guarantee" or "free trial" period so that the lens can be returned for a full cash refund if it is not satisfactory. No photographic equipment should be purchased without such a guarantee.

At first glance it would seem that photographing distant landscapes should require long-focus or telephoto lenses. This is not necessarily so. Many long views owe their impressive sweep to a "wide screen" effect. Therefore a wide-angle lens, which will include more of the scene, is often better for landscapes than a long lens, which would isolate a smaller segment and render it larger on the film.

No photograph can capture the full effect of a scene as it is experienced firsthand by a viewer. There is no photographic technique that can record landscapes quite as they appear to the eyes. The human optical system combines an extremely wide angle of view, variable focal length, and full-color stereo vision with a built-in compensating system unequaled by any computer.

The photograph is different from the actual scene. It has boundaries and it is flat. The photographer's problem is to create something new within this frame—not a reproduction of the landscape (which would be impossible), but a thing of beauty in its own right.

For photographing wildlife, long lenses are generally required. They are unavoidably heavy, because optical glass is dense and quite a lot of it is used in most long lenses. Slower lenses (those with relatively small maximum apertures) are smaller, lighter, and less expensive than fast lenses of the same focal length and work well in good light. Lenses with barrels made of aluminum alloys instead of nickel-plated brass are materially lighter. They are hard to keep steady when hand-held, but are satis-

LIGHT PHOTO OUTFIT is recommended for use in mountains.

ZOOM LENS is useful for following movements of subject.

factory at high shutter speeds or when the camera is used on a firm support. There are also a few "convertible" long-focus lenses, which come apart so that the separate components can be used singly or in combination to yield two or three different focal lengths from one lens. All of them are slow lenses.

A reduction in weight and a great increase in convenience are provided by the new "zoom" or variable focal-length lenses for the single-lens reflex cameras. The best have automatic diaphragms, stay focused on a given spot when the focal length is changed, and are comparable in quality to fixed focal-length lenses. Although zoom lenses are long and heavy, they are lighter than the four or five individual lenses that might otherwise be needed to cover the same range of focal lengths, and they are easier to use. The photographer who is on top of a mountain peak cannot move in for a closer view or back for a wider one; he must change lenses or change the focal length of a variable lens.

ARTIFICIAL light sources are ordinarily not considered for field work because of their weight, but some special situations may require them. For photographing nocturnal subjects or cave interiors, miniature flash bulbs give the most light per ounce. It should be remembered that a single artificial light source rarely produces satisfying pictures, so equipment should be available to introduce back and side light as well as front light.

When high speeds are needed to stop motion, electronic flash is the only answer. "Strobe" units have been greatly improved in recent years, and there are now battery-powered units that are truly portable and give a great deal of light. Some of the increased light output has been obtained by lengthening the flash duration, which reduces its ability to stop motion. Therefore a unit should be tested to insure that its speed is sufficient for the intended use *before* it is taken into the field. Another point that should be checked is the number of flashes that can be expected from one set of batteries. If spare batteries are required, their weight must be added to that of the unit in comparing it with others. Manufacturers' claims regarding battery life should be verified by test.

FOR producing enormous quantities of light, nothing can surpass old-fashioned flash powder. It is still being made, although suppliers who stock it may be hard to find. It must be handled with great care because of the danger of explosion, and it should not be used in confined spaces because it produces enough smoke to make a second exposure impossible. Flash powder does not synchronize with the camera shutter as electrical flashes do, but the blast can be delayed by means of a fuse to give the photographer time to get back to the camera and open the shutter.

If a continuous light source is required rather than a flash, there are still ways of providing one far from electric power lines. Gasoline pressure lanterns or automobile headlights will do, and portable battery-powered movie lights are available. Like flash units, such sources must usually be used with reflectors or additional back and side lights to overcome excessive contrast and give an effect of "roundness" or "depth" to the picture.

However, these are desperate measures, to be taken only when artificial light is absolutely necessary. The most satisfactory light, as always, is daylight, which can be controlled adequately with little or no special equipment. A leafy tree branch can serve as a shade, and a white shirt or towel may be used as a reflector. (A colored shirt or towel can be a reflector in black-and-white photography, but not for color, as it will tint the light reflected from it.) Small, bright reflectors can also be made from aluminum foil. I have even used the inside of a camp frying pan, and with good results. For close-ups, little mirrors like those supplied with ladies' handbags will substitute for spotlights. Army-type metal mirrors are a bit larger, lighter, and less subject to breakage.

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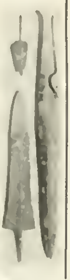

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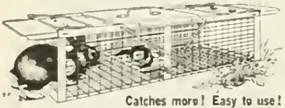

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DAVID LINTON's by-line has appeared under photographs in all the nation's leading magazines. His camera column is featured regularly on these pages.

Tripods are likely to be bulky, but they are worth carrying if they have convenient controls. Many recent models are of light, strong alloys, and are shorter when folded and more rigid when opened than older types. No tripod should be considered if it does not have an "elevator," or movable center post. These not only make it easy to raise and lower the camera, but they can also be inverted to position the camera below the apex of the tripod when photographing flowers and other small subjects at or near ground level.

A camera clamp should always be carried, even when a tripod is taken. The clamp must have a universal ball-and-socket joint and a screw to fit the tripod socket on the camera. The smaller clamps will fit easily into a pocket, but may not have wide enough jaws to grip some potential supports. With a clamp, the camera can be mounted on any convenient object. A walking stick makes a good unipod, and several poles can be lashed together to improvise a tripod. Attaching the camera to a tree sounds like a good idea, but it isn't. Trees sway in the wind and only the lower trunk of a large tree is relatively motionless. It is better to drive a stake into the ground and clamp the camera to it.

There are two schools of thought as to how cameras should be carried. One contends that cameras should always be ready to shoot in an instant. The shutter speed and aperture should be set for the average of prevailing light conditions and the lens focused at the hyperfocal distance (see article on focus, NATURAL HISTORY, November, 1960). The camera should be carried, if not in the hand, at least slung around the neck so that the photographer can raise it to his eye and shoot with one quick motion.

Extremists among this "quick-draw" group disdain the use of cases and even of lens caps. The latest fashion is to keep a filter always attached to the lens to protect it.

There are no reliable statistics on the incidence of camera repairs among this group, but an informal survey by the author suggests that few good pictures are waiting to jump out at the photographer. An unprotected camera carried all day on dusty trails or snowy slopes is likely to develop trouble, and the nearest repair shop may be far away. In carrying an open camera one also risks burning a hole in a focal-plane shutter. The lens acts as a burning glass, concentrating the sun's rays on one spot on the shutter curtain, which is usually made of rubberized cloth, until it burns through. Using a lens cap eliminates this danger, and a camera case provides additional protection against dust and accidental damage.

The opposite school of camera-carrying claims that good pictures almost always require planning, and that protecting the camera from dust, dampness, heat, and hard knocks is more important than having it ready for instant use. Extremists of this school wrap their cameras in spare clothing and stow them in the middle of a pack or duffel bag. This results in many lost picture opportunities when getting at the camera is just too much trouble.

Perhaps a middle road is best. The camera, in its case, could be carried in the top of a pack when picture taking is not imminent, and around the photographer's neck between shots. When several people are hiking together, it is easier for the photographer to reach his camera if it is in someone else's pack rather than his own. This also lightens the photographer's load. It is a good idea to keep the camera and film in tightly closed plastic bags. Excellent bags for this purpose are available on the surplus market, labeled "Cover, Waterproof, Pistol or Personal Effects." If properly tied they will withstand dust and rain and even a short dunking while fording a stream or loading a canoe. They will not protect a camera from hard knocks.

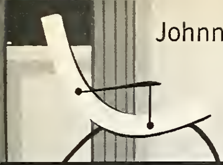
When the camera is carried "at the ready" it should be hung around the neck at chest level, and secured against swinging with a snap that engages a ring on the camera case. The snap is attached by a lanyard to the photographer's belt or between the shoulder straps of his pack. Fancy rigs of this type use lanyards of elastic shock cord. Accessories should be carried in a pack or saddlebag, since conventional gadget bags are not suitable for rough travel.

Nothing can spoil a trip to the wilds as quickly as an overload, but ample film is worth its weight. And nothing can add so much to the enjoyment of a trip, both during and afterward, as making a portfolio of excellent photographs.

This list details the photographer, artist, or other source of illustrations, by page.

COVER Fred Baldwin
3 Joseph Sedacca
10-19—Sven Gillsäter
20-25 David L. Dineley
26-31 Fred Baldwin
32 New York Public Library
34-37—AMNH Archives except 34-bot., Handbook of South American Indians issued by The Smithsonian Institution
38-49—Vladimir Kozák
50—AMNH Archives
52-53—Sky Map after Henry M. Neely
54-55—John S. Shelton except 55-bot., Kenneth S. Norris
56-57—Kenneth S. Norris except 56-bot., AMNH
58-59 John S. Shelton
60-63—David Linton

Johnny isn't watching the late show tonight . . .



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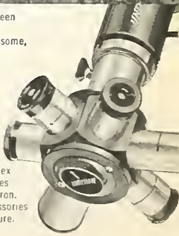

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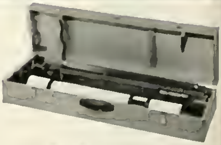

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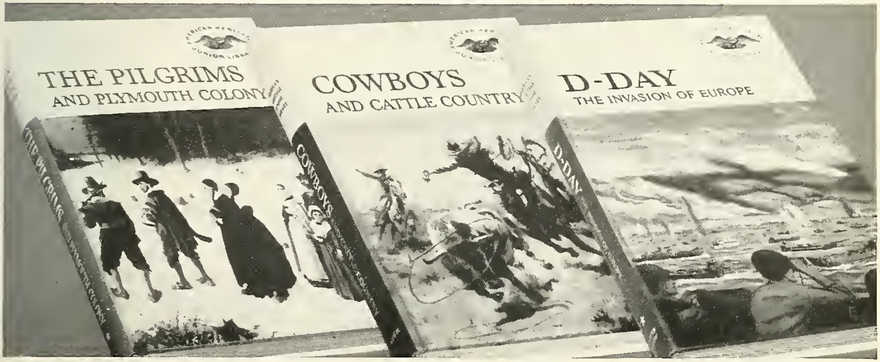

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Vol. LXXII FEBRUARY 1963 No. 2

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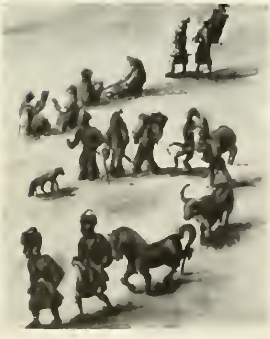

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York 24, N. Y. Published monthly, October through May; bimonthly June to September. Subscription Price: $5.00 a year. In Canada, and all other countries, $5.50 a year. Single copies: $.50. Second class postage paid at New York, N. Y., and at additional offices. Copyright, 1963, by The American Museum of Natural History. No part of this periodical may be reproduced without the written consent of NATURAL HISTORY. The title NATURE MAGAZINE, registered U.S. Patent Office. Unsolicited manuscripts and illustrations submitted to the editorial office will be handled with all possible care, but we cannot assume responsibility for their safety. The opinions expressed by authors are their own and do not necessarily reflect The American Museum's policy.

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Reviews

Books on ethnic art for both scholar and dilettante

By Harry Bober

LAROUSSE ENCYCLOPEDIA OF PREHISTORIC AND ANCIENT ART, edited by René Huyghe. *Prometheus Press, $17.95; 411 pp., illus.* THE HORIZON BOOK OF LOST WORLDS, edited by Marshall B. Davidson, text by Leonard Cottrell. *American Heritage Publishing Co., $17.95; 431 pp., illus.*

IF the stream of books in the sphere of archeology is any true indication, there is a flourishing and insatiable appetite among the general public for accounts of the histories and mysteries of civilizations long past and far away. The lure is universal and age-old, but the accelerated publication in this field, within the last dozen years alone, is most extraordinary. It is something of a phenomenon worthy of thoughtful examination for what it may tell about ourselves and our age. However, our immediate purpose is to review two new specimens of the myriad seasonal productions in this area. Both are directed to a non-professional audience and it is especially instructive to consider them together, for both are serious and ambitious efforts from opposite extremes in the scale of popularization. Each is so completely typical of its sponsoring press that to name the publishers is to hoist the banner of their essential peculiarities and method.

The Larousse work is indeed encyclopedic. It is of the good old Larousse tradition in its academically systematic plan, solid execution, and didactic exposition. *Lost Worlds* is a Horizon book; as smart, lavish, and finished in its way as the best of Hollywood or Madison Avenue. It flashes glamour from every facet, tells its story with romantic confidence and colorful dramatization. Each is a highly successful performance of its kind, and there would be little point in comparing them qualitatively since they serve utterly different needs, interests, and purposes. Still, they must be displayed descriptively and analytically so that the reader may know what to expect. The juxtaposition of this pair is particularly instructive, for the contrast between them sharpens the focus on their separate natures.

The *Larousse Encyclopedia* is soundly French, like the French schools where you go to work and to learn. The aim of this book, the editor tells us, is not "to pander to idle curiosity" but to summarize and synthesize the present state of knowledge and scholarship in prehistoric and ancient art. Facts, presented as completely and concisely as possible, coupled with essays giving an over-all view of each area or period, form the core of the text. The divisions in the contents of this book follow the academic canon of current history of art, ranging from prehistory through Roman times, including primitive art and that of ancient Asia. The main articles are written by twenty-five first-line specialists of international reputation, each hewing to his assignment to produce a concentrated, detailed panorama of his field in clear and unpretentious style. A service crew of seven well-qualified researchers contributes pithy historical summaries to each essay, giving basic chronological and geographical data, tables, and other relevant background information. René Huyghe has prefaced each article with a short essay on "Art Forms and Society" as it applies to the separate areas. Whatever his views, and they are conventional and debatable in fundamental respects, his introductions provide a thread of structural unity, without intruding upon individual views expressed by his team of scholars. Even the illustrations in the book are subordinated to serve the text as instructive and abundant auxiliaries, of adequate but sensibly small size. The color plates, while occasionally very good, are equally often very poor, but they constitute a small and "detachable" *hors-texte* group that leaves the book unaffected.

Compared with *Lost Worlds*, the simple and attractive Larousse volume will seem ordinary if not plain. *Lost Worlds*

DR. BOBER is an art historian with New York University's Institute of Fine Arts and is distinguished for his contributions to the studies of both the medieval and primitive art forms.

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is a stunning production and bears the stamp of Marshall Davidson's wit and taste. Indeed, the production of the book dominates its entire character. Excellent paper and plates, attractive binding, inventive layouts, ingenious combinations of color with black-and-white illustrations make it an unflaggingly arresting panorama. The choice of Leonard Cottrell to write the book proves, for this purpose, excellent; it gives a textural and stylistic continuity in fluent and energetic prose. The lengthy and well-composed legends for the illustrations make this a book that one may pick up at any point and read with interest.

That a single author could write this entire text, covering some nine different "early worlds," is a feat indeed. It seems even incredible when we note that *Lost Worlds* is not a history of ancient art. Instead, it tackles the totality of each cultural complex, embracing them entire, from archeology, philosophy, and religion to daily life, manners, and customs. The works of art reproduced serve to provide graphic documentary illustrations for this approach. It is a remarkable tour de force that many readers will doubtless relish and in which they will find stimulus to broader interests.

How do we explain this phenomenon of an author who can deal, singlehanded, with more matter than a score of professional scholars? It is claimed that "this superb word-and-picture documentary is a magnificent *original* history." The answer is that where it is original it is not history, and where it is history it is not original. The author's skill and achievement should not be confused with scholarship, least of all "first-rate scholarship," as advertised. Where scholarly disciplines are concerned, journalism can only be a bridge, however excellent, but the best of bridges is still not the solid land that it joins. It should be sufficient to acknowledge a man's gift for assimilating and processing scholarship with a high degree of literary competence. Unkind indeed would that scholar be who ventured to examine and analyze *Lost Worlds* as a scholarly work.

Of the two books it might be said that they differ as does an old-fashioned dinner (from soup to fruit and cheese) from cocktails and canapés. This is neither bad nor good unless you offer one for the other. For the serious non-professional student or for the small library, the *Larousse Encyclopedia* will prove useful for introductory instruction and for a wide range of reference in the spheres of ancient art. For the conscientious dilettante, Horizon's *Lost Worlds* will provide exceptionally good intellectual snacks. The one is a working book for the study; the other will provide a superior coffee table asset.

Primitive Art, *by* Paul S. Wingert. *Oxford University Press, $7.50; 421 pp., illus.* Primitive Art, by Douglas Fraser. *Doubleday & Co., $7.50; 320 pp., illus.*

Paul Wingert considers his book an introduction to "one of mankind's great artistic achievements. . . ." As an art book, it is traditional in both form and scope. Space requirements have not permitted a full treatment of the major aesthetic sections of the cultures he covers, and he has omitted music, dance, and folklore. Of the visual arts, plastic art (primarily sculpture) is described.

In his survey of the West African and Congo carving areas, the author analyzes selected masterpieces from the "style centers," black-and-white illustrations accompanying the text. Later, in dealing with Oceania, he repeats the process with Melanesian and Polynesian materials. Lack of space again forces him to consider only part of the total area. In this section, the sparse carving production of Polynesia prompts him to add other types of art to even up the picture. Other authors have described weapons and tapa cloth designs. Wingert adds architecture to the list. His last descriptive unit is a brief survey of North American Indian art. Here, the style-center concept is least rewarding, since it is difficult to compare groups that work in such totally different mediums: pottery, basketry, masks, and paint (for buffalo robes).

Partly because of a lack of sparkle in the photographs, Wingert's *Primitive Art* produces an impression of studiousness that dulls the excitement and impact of the art.

Primitive Art, by Douglas Fraser, is written with a dramatically different view and method. While limited to the visual arts—sculpture primarily the author's eye is on far horizons both in time and space as he searches for "new relationships." African carving is here grouped under a single main head instead of under the tribal styles that have become so familiar. Based on a well-known linguistic analysis, Fraser posits a generalized megalithic style featuring a heart-shaped face. In the Pacific, he refuses the traditional Micronesia-Melanesia-Polynesia-area framework as "unsatisfactory," and proposes eight layers of prehistoric culture contact that have flooded out at various times into the Pacific from the Asian mainland. A section treating the archeological and ethnological material of the Americas is likewise rich in continued Asiatic contacts. "Scholars who believe that pre-Columbian advances took place in isolation must explain why such developments occurred in precisely the Oriental sequence. . . ." he says.

Art is apparently always carried or borrowed, in this view, and is never developed or refined. Evidence is presented for contact between Scandinavia and the Solomon Islands, Thailand and New Ireland, New Zealand and Taiwan, and between India and Tahiti. The author says that this last contact arrived in Tahiti by way of Luzon, in the Philippine Islands, and uses as "proof" a wooden figure whose nailed arm can be raised to produce a typical Indian gesture of obeisance. Illustrations, many of them in brilliant color, are used with the text to make his visual evidence clear. This book gives the impression of a network of lines of possible contact spread over the globe, beneath which cultures and artists are but dimly seen.

Coincidentally, the books of both art historians, on the same subject and selling for the same price, have appeared at the same time. Both men are instructors in the same department at Columbia University. Since both used comparable collections of source material, it is instructive to compare their remarks and divergent points of view:

Wingert: "Primitive art refers to the artistic output of literally thousands of often small, areal cultures, each of which developed and nurtured its own art tradition . . . inextricably associated with such major cultural facets as religion, society, economy, and politics . . . an understanding of primitive cultures is surely a prerequisite to a more complete appreciation of their art."

"It is essential to recognize these highly unusual shapes for what they are: the expressions of deeply rooted art traditions. . . ."

Fraser: "To assume that a style has no past and is entirely a local phenomenon . . . condemns art objects to solitary confinement in an artistic limbo. We will try to correct this distortion."

"We must not make the mistake, however, of insisting on linguistic or cultural support for artistic connections. Art changes faster and travels further than culture. . . ."

"The most interesting connections of all, of course, are those that are far away in time as well as in space."

It is a truism that any ethnic factor—such as a mask or a carved figure—can only be appreciated in its total situation. Stripped of costume, motion, and the reaction of an aroused audience, a mask can hold only a fraction of its real meaning. Combining such partial truth with Western aesthetic analysis is a weak broth for an anthropologist or for the art enthusiast. Wingert's book treats no single culture in depth. To search for artistic insights, as Fraser does, by comparing exotic cultural fragments for possible resemblances is to be satisfied with very little. One might as well eat the seasoning and throw the roast away.

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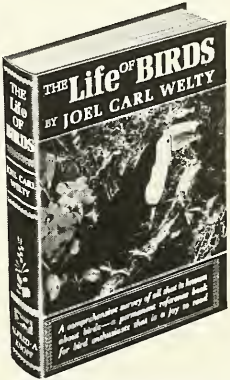
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H. WIMMER

Space Tracks

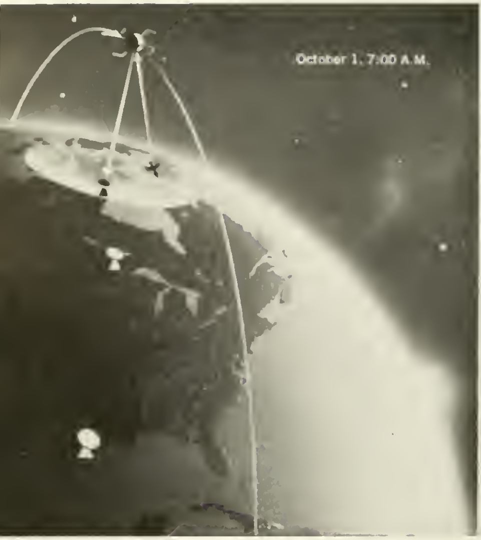
Bioelectronics extends its frontiers

By Dwain W. Warner

IN THE FEW YEARS that have passed since the mid-Twentieth Century, we have come to the realization that technology has developed both the power and the tools to enable us to explore more completely earth, space, our moon, and even nearby planets. These explorations, which at present fall almost entirely in the realm of the physical sciences and engineering, are proceeding at a rate few can grasp.

Meanwhile, biologists, and especially those concerned with the studies of the natural environment and its faunal and floral elements, have noted the marvelous accomplishments with mixed feelings. Particularly they have envied the new tools for making numerous measurements, which, in turn, have led to the accumulation of vast amounts of information—as, for example, during the recent International Geophysical Year. It has, after all, been only very recently that instrumentation, more sensitive and comprehensive than the human senses, has been developed for the acquisition of these data.

The field biologist, unfortunately, still depends largely on sight and hearing for his information and, as a result, often obtains data too discontinuous and incomplete for reliable statistical analyses and interpretation. Yet the same biologist also recognizes that, except almost peripherally, the information and measurements that have been collected by the physical scientists, who have always been considered to be in a discipline apart, have been but little concerned with life of the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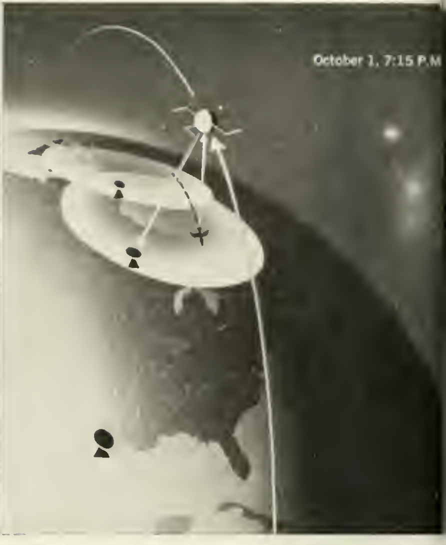
Transmitter signals from an animal could reach satellite orbiting 200 miles above earth from an 800-mile distance.



Signals from satellite could reach a ground station (key symbol) from 1,200 miles. Each orbit could "scan" an area

earth on which we live. Interdisciplinary research between biologists, physical scientists, and engineers in studies of our natural environment has been slow and pursued with reluctance.

More than thirty years ago the conflict was expressed by the pioneer ecologist Dr. Royal Chapman who, in 1929, wrote: "Ecology is bound to become quantitative. Many of us are observing this inevitable tendency with regret. There is a feeling that the wonders of observational natural history are to be brushed aside by the cold, dry calculations of a mechanistic mathematics. . . ." But he added: "The urgent needs are, first, more accurate measurements of environmental factors and the populations which make up the natural associations, and, in the second place, better methods of evaluating the measurements of the factors."

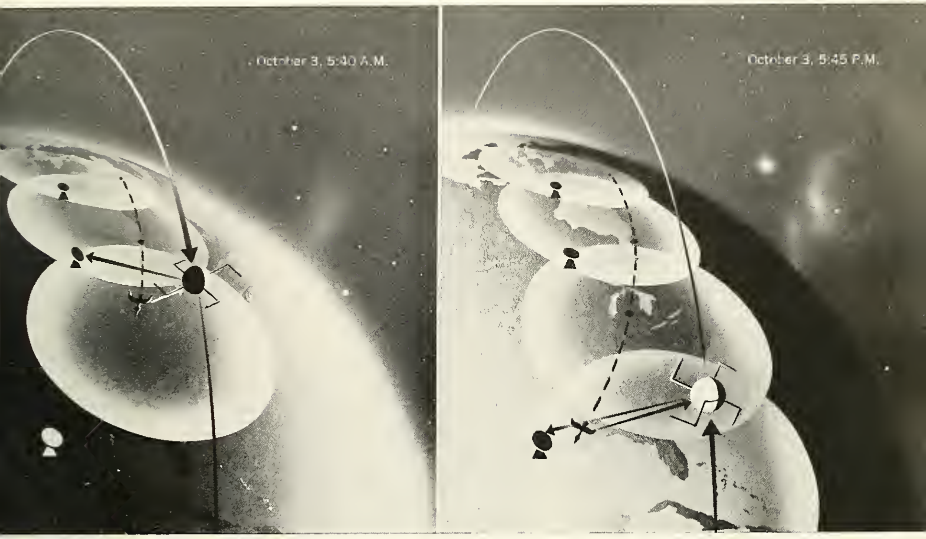
A brief review of one aspect of man's efforts in these directions may help to put into better perspective the need for expanding interdisciplinary research and the real potential of modern instrumentation as applied to the biological sciences.

Watching and listening to the passage of animals in their seasonal migrations has been a necessary and traditional behavior pattern of man since he began to evolve as a flesh eater. Increasing curiosity about bird migrations led to the first markings of individual birds several hundred years ago, and the usefulness of this technique was well recognized by the early 1900's. As a result, several million birds and many other animals have been tagged with numbered metal bands or with various color markers. But this method has told us only a little of an animal's movements, for band recoveries represent a relatively small percentage of the marked animals. Usually, all we have available as an end result are two points on a map—the banding and recovery sites—with a known time interval, but an unknown distance of travel, between. This information has served many purposes, but has contributed little or nothing to understanding the animal's orientation, navigation, or relationship and responses to its environment.

Now, observations of an animal's motility are of utmost significance. Since the environment apparently furnishes or modifies the stimuli that trigger basic responses, the ability to follow an animal's movements continuously and to attempt to correlate these movements with environmental factors seems essential to advances in ecology. Nearly all animals are at some time motile, and since the causal factors of this motivation are not adequately understood, major emphasis must be given to a continuous recording of animal movements correlated with other environmental events.

For instance, various researchers have gathered data indicating a relationship between the distribution and abundance of animal populations and the biotic and physical forces of their natural environments. However, only a few quantitative studies on an individual animal's motile responses to environmental factors have been attempted *under natural conditions.* In addition, relatively few studies have been concerned with accurate measurements of the effects animals have on their immediate microclimates and the relation of these alterations to the animal itself and to its habitat.

In order to describe a total energy balance of an environment, the following physical properties must be measured: absorbed and reflected solar and infrared radiations, air and soil tem-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1,600 miles across; the overlap in successive 103-minute orbits would depend on latitude. Due to earth's rotation, a satellite that passes south over a point on one orbit would pass north over same point some twelve hours later.

peratures, relative and absolute humidities, precipitation, and barometric pressures. Current advances in instrumentation give hope for truly accurate measurements of these and many other variables. Movement studies have previously been based almost entirely on visual observation, recapture of previously trapped and marked individuals, and on the appearance in study areas of species intermittently capured by various sampling methods. From these studies have come current nterpretations of an animal's response to environmental change, the area of ts "home range," its migration and dispersal, population structure, and even conclusions on systematics, evoution, and biogeography. Under conditions of adversity, an animal adjusts physiologically (for example, by changing heart, respiratory, and metabolic rates). It may shift its position in its normal home area: it may migrate; it may die. If we use the problem of animal movements and environmental stimuli as a basis for interdisciplinary research among engineers, physical scientists, and biologists, what can we present as a feasible technique to give us results of an importance equal to those being obtained by researchers in the physical sciences?

Of course, the development of radar during World World II enabled us to "see" movements of birds both day and night on the radarscope and on film, and also to see weather and the responses of the birds to it. It now allows us to measure, within the radar's range, the magnitude and speed of the migration, altitudes of flight, and direction. But we cannot very accurately identify the birds as species nor can we distinguish between individuals and flocks. The use of radar by biologists evolved slowly—partly as a result of wartime security measures and partly because of the reluctance of many scientists to recognize that nearly all "angels" seen on radar were really birds. (See NATURAL HISTORY, October, 1961.)

WITHIN the last three or four years, the availability of transistors and other miniature and now microminiature electronic components has given us another major breakthrough in the study of animal movements in their natural environment. Tiny radio transmitters, which, together with batteries, weigh less than an ounce and which can transmit a signal for weeks, have been placed on or in animals. To date, ruffed grouse, cottontail rabbits, woodchucks, porcupines, skunks, and other animals have been located intermittently by portable receivers carried in the field. Some of the results obtained have been both surprising and dramatic. The transmitted signal was sometimes altered by the behavior of the animal and by one or more body functions. Changes in the signal have distinguished between a resting and a flying bird, and analyses of signals recorded on paper have given accurate measurements of rates of respiration and wingbeats of a mallard duck.

Information on relatively sedentary animals and their environments may become known by telemetering data to ground stations over short distances. But radio signals do not curve, as does the earth's surface, so signals traveling along the ground are largely lost over any considerable distance. Thus, tracking long migratory movements would require either numerous receiving antennas on ground towers or planes equipped with receivers—a tremendous expenditure in equipment and manpower.

Is there any way we could obtain line-of-sight radio signals from numerous animals that may be moving over vast distances in all three of the earth's mediums? How can we find out where the penguins of Antarctica go after mating season; the routes of the wandering albatross or the Caribbean turtle; the forces governing caribou movements; the track of the Canada goose? One tool in common current use by physical scientists and engineers could answer all these and many more. That is the artificial satellite.

SATELLITES carrying various instruments have already relayed back to earth vast amounts of data in the fields of geophysics, radiation, and other aspects of space studies. Most instruments for making these measurements and the radio transmitters for sending the data back to earth are very small in size and light in weight. What equipment would be needed to locate animals on various parts of the globe and to transmit the information back to earth? To obtain the necessary calculations, I went to my colleague, William W. Cochran, Director of the Bioelectronics Laboratory in the Minnesota Museum of Natural History. His experience in designing and building both satellite- and animal-borne radio transmitters and receivers places the following instrumentation plan beyond the realm of mere speculation.

A satellite could be instrumented to receive and relay to ground stations the signals obtained from many transmitter-carrying animals in various parts of the world. Initially, we might seek only the migration track of each animal. Cloud patterns and perhaps other meteorological and geophysical data that might affect animal movements might be available from measurements made by other projects (such as the Tiros satellites) for areas of the earth over which birds would fly or swim. These data could provide information on such phenomena as disorientation of birds under conditions of overcast. Successes in tracking animals on a world-wide basis by the use of a satellite would, it is hoped, provide guides for further instrumentation to telemeter one or two physiological or environmental factors concurrently with migratory movements.

Species that could be tracked by this method, and for which prototype transmitters have already been designed and tested, are larger birds such as geese, swans, cranes, penguins, and albatrosses. Among mammals the caribou could be tracked in its migrations. Species in these groups are large enough to carry currently available transmitters and power supply. Their modes and regions of travel and their physical environments are so different that numerous tests of the instrumentation could be provided effectively. For example, Canada, blue, and snow geese, which could be tagged with radio transmitters, pass over much of continental North America, moving mostly in long, direct flights. The longest nonstop flight is probably from James Bay, the southern extension of Hudson Bay, to the Gulf Coast of Louisiana and east Texas.

Instrumentation to track these and other animals on a global basis could be relatively simple. Each animal could carry a transmitter and power supply weighing approximately 20 to 60 grams. The satellite, traveling 18,000 miles an hour (approximately 5 miles per second), at an altitude of 200 miles above the earth in a polar orbit, would cross over both North and South Poles once about every 103 minutes. In the satellite would be a receiver and transmitter weighing a few pounds — or possibly even less — and occupying perhaps half of one cubic foot of space. Power supply, of course, would require additional weight and space, but might be supplied by solar cells, which would extend the period of tracking and would weigh less than batteries.

IN order to receive the signals from the satellite at all times in its flight, twenty-four optimum-located receiving stations would cover the earth. A tape recorder at each of the ground stations would record the signal that had been received in the satellite from an animal-borne transmitter and then retransmitted to earth. This tape would then be run through an audiospectrometer. The spectrograph would be displayed and used—together with the known positions of the satellite in its passes within the line-of-sight range of each animal—to locate the animals at various times of day and night.

TRANSISTOR carrying case, at right, *above*, is around neck of goose at left. Size of instrument is apparent, *below*.

Some of the details of this tracking method might be of interest. The tiny radio transmitters, each with its battery pack, would be no larger than the first joint of a thumb. It would be attached to a simple harness with the antenna forming one of the harness loops around the body of the animal. It has already been found that animals adjust relatively easily to harnesses that do not inconvenience their habits. The entire unit would weigh some two ounces or less, depending on the number of batteries. The transmitter signals would be intermittent pulses, each at a slightly different frequency and, therefore, distinguishable from others in the same part of the earth.

To help determine just how far a signal from these small instruments could be received, we attached half-ounce transmitters to high-altitude balloons used for research by the University of Minnesota Department of Physics. With radiated power of much less than one microwatt—far less than that anticipated for satellite tracking—we received the signal from 270 miles away when the balloon was 25 miles above the earth. And this was in a region of considerable radio interference. The test adequately demonstrated the feasibility of long-range line-of-sight transmission.

The proposed satellite would contain a receiver and an antenna tuned to that band of frequencies occupied by the transmitters. Satellite transmitter power should be at 500 microwatts to assure a satisfactory signal (distinguishable from all types of interference) at the ground receiving sites. A lower power could be used at the expense of adding or utilizing more ground receiving sites.

Signals from the satellite could be received by a ground station at a distance of about 1,200 miles. The satellite could receive signals from the animals up to about 800 miles. Thus, the effective coverage area for one receiving station for tracking animals is about 4,000 miles across. Therefore, one station near the center of North America could conceivably cover most of the United States and Canada. A few stations in the Pacific islands could cover the whole Pacific area.

In instrument tests, a balloon with a half-ounce transmitter sent signals for 270 miles from a 25-mile altitude.

Each orbit of the satellite "scans" a swath about 1,600 miles across, as illustrated on pages 10 and 11. The overlap in successive orbits depends upon the latitude. No overlap would occur at the Equator and a 100 per cent overlap would occur at the Poles. Thus, in equatorial zones, two locations, or fixes, a day are possible. In temperate latitudes, four fixes daily are possible, and in arctic latitudes about 14 (the number of orbits per day). Of course, to get a fix the satellite must be in range of both the receiver and the tag on the animal, so the maximum number of fixes is obtained only if ideal receiver distribution is used—that is, at least one receiver must be so located as to cover any point in the area concerned. This means that receivers can be spaced somewhat less than 1,200 miles apart, depending on the area covered, whereas for computing coverage, a radius of about 2,000 miles from the ground station can be used. For example, on Pass No. 1 of the satellite both ground station receiver and tag transmitter are in range of the satellite; but on Pass No. 2 only the tag is in its range. Thus, if we consider the number of fixes as the number of times the satellite is in tag range, we must provide receiver coverage to insure satellite contact. This means an overlap of receiver circles, each 1,200 miles across. But if we are only interested in complete coverage and not in the maximum number of fixes possible each day, we can use overlapping 2,000-mile circles. This is of importance at low latitudes, where tagged animals could be missed.

We have said that if a satellite is 200 miles high it will cross over both the North and South Poles once every 103 minutes, or every one hour and 43 minutes. (Its orbit can be thought of as fixed in space, for although precession occurs, it is very gradual.) If the satellite passes northward over point A on the Equator at noon, it will pass southward over the Equator 51½ minutes later, approximately on the opposite side of the earth. About 103 minutes later it will return, but this time it will pass over the Equator about 1,600 miles *east* of point A, which is the distance earth (and point A) has rotated during the satellite's orbit. The next orbit will be about 3,200 miles east of point A, and seven orbits after crossing A the first time, the satellite will pass over the Equator about 11,500 miles east of A, going north. Since 11,500 miles is about one half the circumference of the earth, point A will see the satellite coming south on its seventh orbit.

In each ground receiving system would be one FM receiver and associated antenna tuned to the frequency of the satellite transmitter, one two-channel tape recorder, and one highly accurate clock to emit sound signals that could be recorded as time intervals. Equipment of this type is available and relatively simple to operate.

Each time the satellite passed within the 1,200-mile maximum range, a recording would be made of the modulation of the satellite transmitter and, on the tape's other recorder channel, of time tones accurate to one second (the satellite travels at five miles per second). These recordings are preserved for analysis. The signals from the transmitters may or may not be heard through the interference, depending on the distance between the satellite and the tagged animals. Much of the time they will be inaudible. The tapes will be run through an audiospectrometer with a resolution of 10 cycles per second, or less; the narrow band width of the spectrometer will reduce the interference to a point at which the signals are discernible.

When these signals are plotted on paper as radio frequency versus time, they form an S-shaped curve. This curve is a result of the Doppler effect between the satellite receiver and the signals coming to it from the transmitter on the animal. This curve, plus accurate time, plus the satellite's path would enable us to locate the animal in a circle 50 miles or less across.

Paradoxically, extracting these data from a single tape may take some 1,500 times as long (about four continuous days) as the four minutes or so required to record it initially, although the time could be reduced by using audiospectrometers with higher capacity.

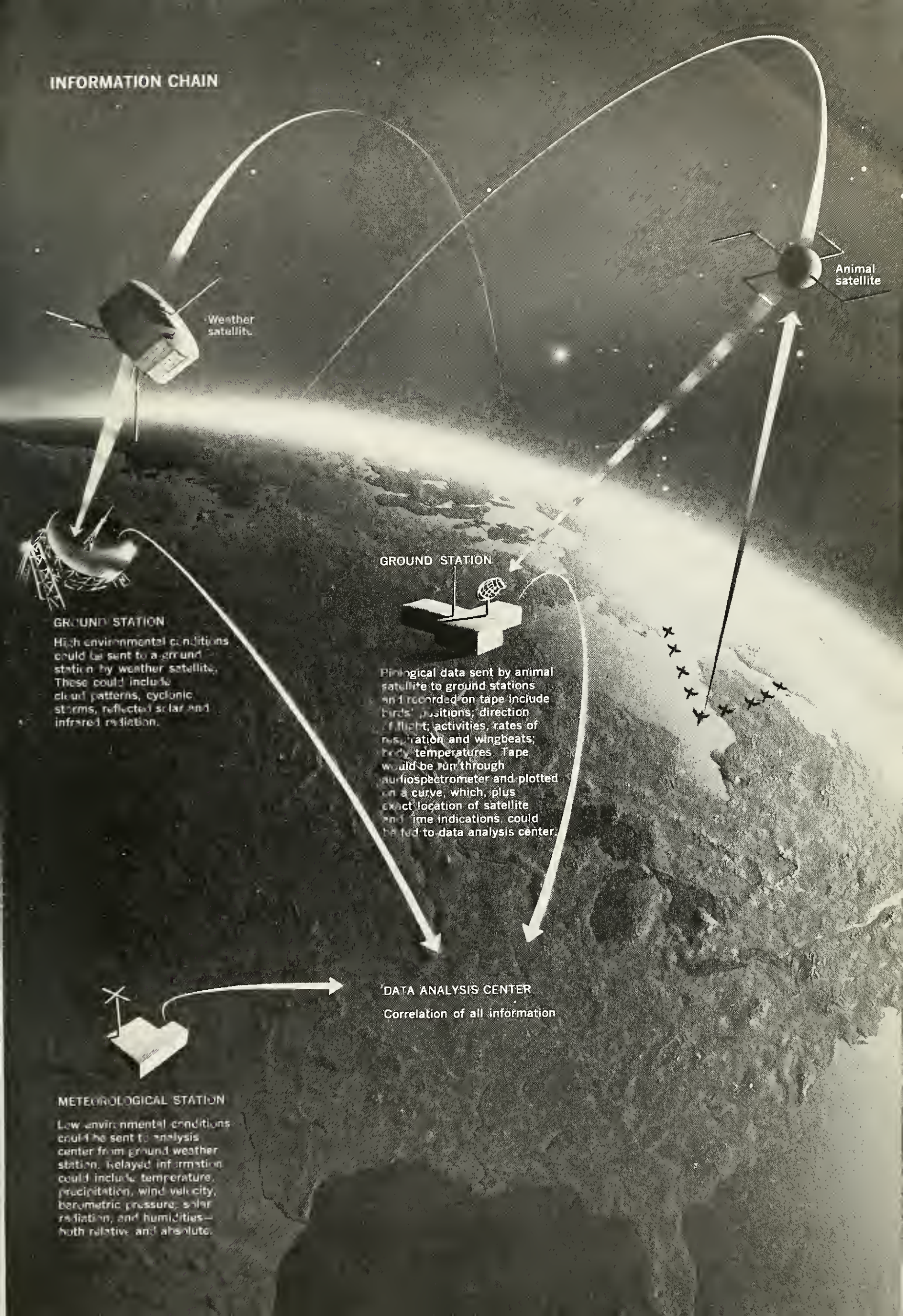
The complexity of analyzing the tapes suggests the creation and use of analysis centers. And here still another field is introduced into this cooperative scientific venture—the adequate utilization of computers whose programing could be jointly undertaken by physical and biological scientists. The information that could conceivably be transmitted by, say, a goose equipped with a transmitter, is almost limitless, at least theoretically. The speed, altitude, and direction of flight are only a few examples. Wingbeat and respiration rates could be sent to the satellite, as could temperatures of the individual animals. These factors could be examined by one of the new biological computers, which have been specially designed to extract desired information from tapes that might be cluttered with various kinds of interference. Latitude and longitude calculations to locate the animals could also be determined to accuracies of about 20 miles, depending on the particular electronic system utilized.

With knowledge of long-distance movements of only a few kinds of animals in various parts of the world, we could begin to obtain data on environmental and physiological factors, and with these to work with, answers could be found to such questions as: does the wandering albatross really wander, or does it follow routes prescribed by environmental factors?

To plan ways in which to use natural resources properly and to expand basic knowledge of the earth's ecologies, more extensive information on the biological and physical factors of the natural environment is obviously essential. It is also essential that such information be acquired at a rapid enough pace to bridge the gap that now exists in data acquisition between the physical and the biological sciences. If biologists are ever to participate in the application, to their own disciplines, of measurement programs such as those demonstrated during the I.G.Y., they must be ready to understand and to use advanced instrumentation whenever it is expedient.

On the last day of October, 1962, seven Canada geese, each wearing one of our transmitters, were monitored at their mid-continent stopover before the last leg of their fall migration flight from the Arctic to Texas. For twelve days previously they had done little flying—they ate, preened, walked, or swam. At that time we could determine the location of each goose and what each was doing by the signals from their transmitters. During those twelve days we learned much about goose behavior at a stopover area. When they left on that last long flight, and disappeared over the horizon, their signals were lost to us on the ground. But those signals were still being sent out into space where, if a satellite had been "listening," it might have been able to tell us infinitely more than we know now about the mysteries of migration.

INFORMATION CHAIN



GROUND STATION

High environmental conditions could be sent to a ground station by weather satellite. These could include cloud patterns, cyclonic storms, reflected solar and infrared radiation.

GROUND STATION

Biological data sent by animal satellite to ground stations and recorded on tape include birds' positions; direction of flight; activities, rates of respiration and wingbeats; body temperatures. Tape would be run through audiospectrometer and plotted on a curve, which, plus exact location of satellite and time indications, could be fed to data analysis center.

DATA ANALYSIS CENTER

Correlation of all information

METEOROLOGICAL STATION

Low environmental conditions could be sent to analysis center from ground weather station. Relayed information could include temperature, precipitation, wind velocity, barometric pressure, solar radiation, and humidities—both relative and absolute.

Success Story of the Opossum

High reproductive rate and low predation favor this marsupial

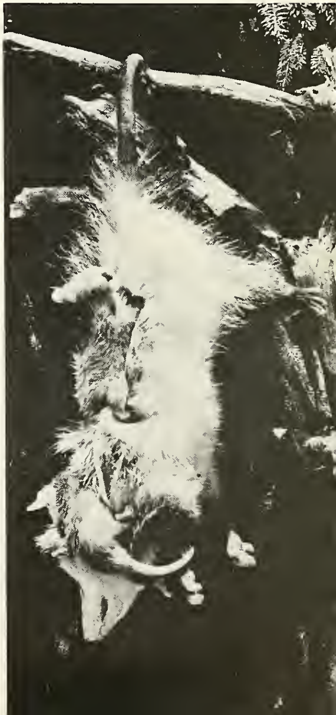
By William J. Hamilton, Jr.

To those of us living in the northern states, the opossum was a rity until the past few decades. Since ne early 1920's, this unusual beast has xtended its range rapidly, emigrat- g into areas where it was unknown n the past. Now it is firmly established rom southern New England to south- rn Minnesota. More at home in milder limates, the creature occupies a vari- ty of habitats, but seems to prefer parsely wooded areas associated with reeks and swamps. It is an adept limber and frequently takes to a tree or fruits or to escape an enemy, but s usual haunts are on the ground.

The ancestral history of the opos- um is long. A fragmentary skull and ower jaw have been recovered from he Upper Cretaceous of Montana, in ssociation with dinosaur remains. 'hese 'possum traces match rather losely the corresponding parts of our resent-day beast, thus placing the possum among the most primitive of nown mammals. Not only is it primi- ive in structure and mode of repro- luction, but it also presumably lacks he intelligence of the placental mam- nals that now occupy the world. There s a great disparity, for instance, etween the brain volumes of a cat and n opossum, although the animals are f comparable size. This can be readily lemonstrated by filling the brain cavi- ies of the two with corn meal and then omparing the resulting piles; the possum has a brain volume scarcely ne-fifth that of the cat. If we examine he two brains, we see that the frontal obes, usually associated with intelli- ence, are small and undeveloped in the opossum, whereas they are large and much convoluted in the cat. The term intelligence, as applied to most wild animals, merely connotes their ability to solve the pressing problems of living. The marsupial brain, despite its small size, seems to be sufficient for these purposes. In fact, the opossum is an animal, little changed in millions of years, that has maintained itself and has been remarkably successful where more advanced mammals, presumably better endowed, have failed to meet changing environments and have become extinct.

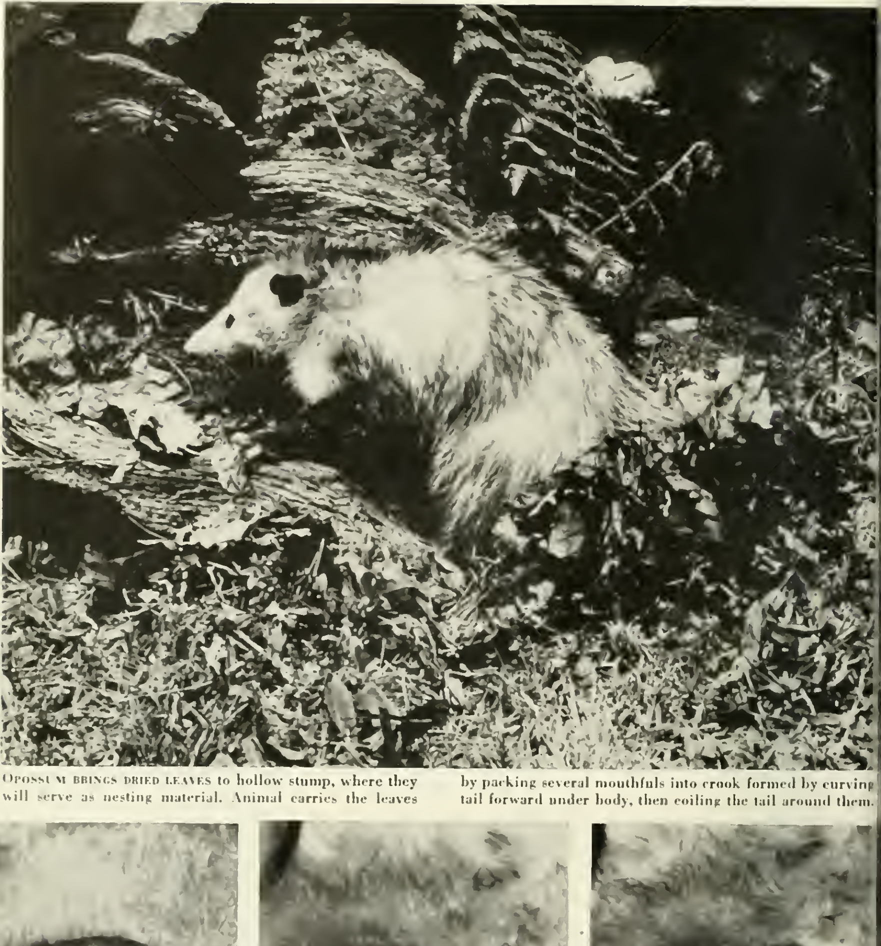
For the opossum is, indeed, successful. Beset by few predators and having a high reproductive potential uncommon in an animal of its size, it has a tenacity of life unmatched by other mammals. Injuries that would spell death to most mammals are of no great concern to the opossum, and an examination of a series of opossum skeletons will very often bring to light the evidence of countless fractures in which the bones have knitted.

Known to the explorers of the New World in 1500, and later to the colonists of North America, the opossum continued to be the subject of fanciful legends for more than four centuries. This folklore is considered by many to be fact, and perhaps no other American mammal has been the subject of so much misinformation regarding the manner of birth. Yet its mode of reproduction, elucidated by careful, direct observation, has been faithfully recorded in scientific journals. The legends of the 'possum's mating and birth are presumably based on anatomical features of both sexes. One widespread myth is that opossums copulate through the nose, and after a lapse of time, the minute fetuses are blown into the pouch. This story probably stems from the fact that the 'possum's penis is bifurcated. The forked ends enter paired vaginal canals, which join the female's two uteri. Thus

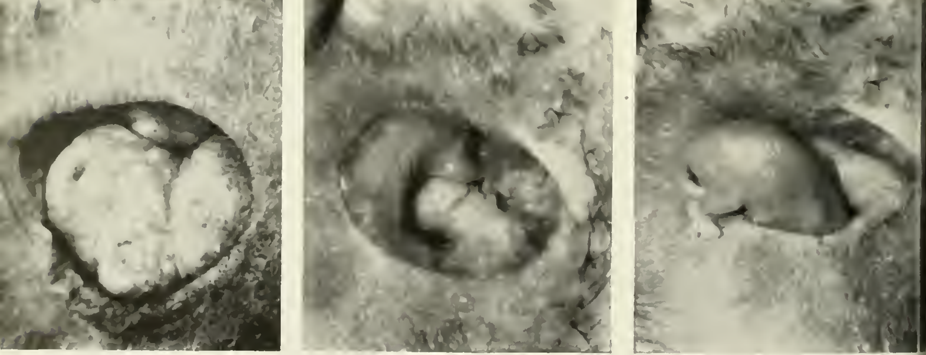


Opossum youngster, eighty days old, peers from mother's pouch. Young may remain in pouch until fourteenth week.

Prehensile tail supports female and young on back. Opossums rarely dangle by tails, and can do so only briefly.



OPOSSUM BRINGS DRIED LEAVES to hollow stump, where they will serve as nesting material. Animal carries the leaves by packing several mouthfuls into crook formed by curving tail forward under body, then coiling the tail around them.



ENLARGED TEATS, *left*, are visible through pouch opening, indicating that large young have nursed recently. Several young are in pouch, *center*. Seven-week-old opossum, *right*, is half out of pouch, but is "anchored" by grip on nipple.

e reproductive organs are different om those of other mammals, which unknown to most observers. The ly double openings in the female's ody that are easily seen are the nos- ils. Moreover, just prior to parturi- on. the expectant mother will spend ome time licking out the pouch to repare it to receive the young. Thus e have an apparently logical basis r a totally erroneous belief.

THE naked. scaly tail also played a part in the fanciful drawings and yths of early naturalists. To be sure. is prehensile appendage acts as a fety device when the animal is pass- g through branches of a tree and e tip is momentarily curled about a mb. Dr. Richard Harlan, an early merican naturalist, gave a good ac- ount of the opossum, but originated me beliefs now known to be falla- ous. Harlan stated that the prehen- le tail of the 'possum enabled the eature to suspend itself from a limb nd thus fall upon and seize its prey. ieutenant DuMont de Montigny, of e Compagnie des Indes, ascribed a ifferent use to the tail. Writing more an two centuries ago. the officer re- tes that the Louisiana opossum. after pturing and killing a small bird, laces it in a clearing beneath a tree. then climbs the tree and, hanging y its tail above the lure, waits for a redaceous bird to seize the morsel. hen the opossum releases its grip, rops on the predatory bird, and kes it and its intended victim.

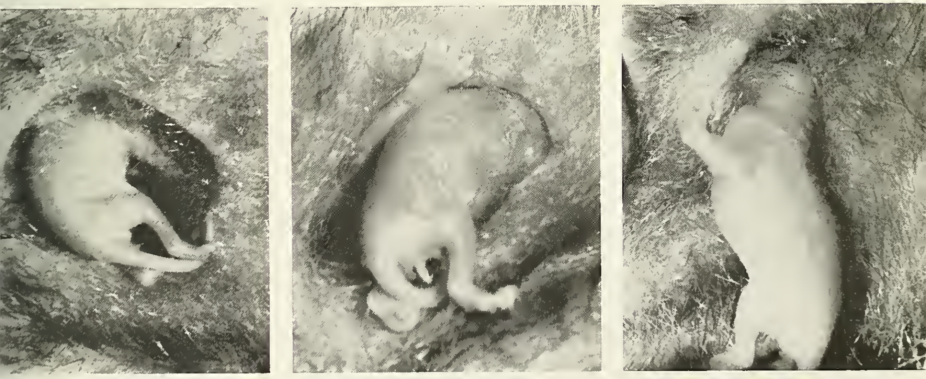
At an even earlier date, the painter Maria Sybilla Merian (NATURAL HISTORY, December, 1962) drew a brood of young opossums riding on the mother's back, their tails twisted about her own. This picture, with some embellishments. was copied by later illustrators. even as recently as 1913.

The photographs that accompany this article illustrate beautifully certain phases of the early life of the 'possum. Most of our information on the embryonic period, manner of birth, and pouch life has been documented only in the past forty years. Today the life cycle of the common opossum, *Didelphis marsupialis*, is better known than that of any other marsupial, notwithstanding the existence in Australia alone of more than 150 species of pouched mammals.

The gestation periods of most mammals are related, generally, to adult size and to the degree of development at birth. Thus many species of mice and rats have a period of three weeks; rabbits and hares, thirty to thirty-eight days; cats and dogs. sixty-one to sixty-three days; sheep and goats. twenty-one weeks; and the cow. nine months. Guinea pigs. which are born in an advanced state, well furred and with open eyes, have a gestation similar to the dog's. These are placental mammals. with fetuses that receive nourishment and eliminate wastes through a vascular placenta attached to the uterine wall.

Quite a different situation obtains with the pouched mammals, or marsupials. Lacking placentae, their developing young are nourished during fetal life by intimate contact with the folds of the uterus. We may liken the wall of the uterus to a tennis ball cut in two and filled loosely with soft tissue. The fetus is embedded in the folds formed by the tissue. It cannot tarry long in this haven. Indeed. only thirteen days elapse from conception to a 'possum's birth. This is the shortest gestation known among mammals, although it is possible that the mouse-sized pigmy 'possums of Australia may have an even shorter uterine life.

AT birth the diminutive opossum, having all the appearance of an embryo, weighs only 0.16 gram. Approximately 170 such tiny 'possums weigh one ounce. Thus the weight ratio of a newborn young to a four-pound mother is roughly 1:10750. The young are so small that two dozen can be accommodated in a teaspoon. The appearance of a newborn opossum is indeed striking. The hind limbs are veritable embryonic buds. A circular mouth opening (the lips do not fully form until the young are seven to nine weeks old) serves only to grasp the teat. Yet one structure is well developed in these mites. The forelimbs are muscular, and the hands have well-developed claws. These appendages enable the young to make their perilous and unaided journey to the pouch. As the young opossum emerges into the world, it is swathed in embryonic envelopes. Clothed in the fetal mem-



ACKS OF YOUNG, *above*, at seven weeks, are darkened by bluish cast, signifying that the pigmented hairs that are still beneath the skin will soon erupt. As the young grow larger, female's marsupium stretches to accommodate them.

branes, the amnion and chorion, it is thus held in a sac of fluid. It lacks sufficient strength to free itself from these embracing sacs and will quickly drown if help is not provided. Help comes from the mother, who licks the membranes free and laps up the amniotic fluid. Now the newborn is ready to undertake its first journey.

MANY conjectural theories about this progress were advanced by early naturalists. Some believed that the mother transported the young directly into the pouch with her lips, others that the birth canal was brought in contact with the pouch opening so that the young 'possum need only grasp a nipple to secure itself. These fallacies were laid to rest on February 6, 1920, when Dr. Carl G. Hartman, then at the University of Texas, observed the journey to the pouch for the first time. He wrote: "Then suddenly a tiny bit of flesh appeared at the vulva and scampered on over the entanglement of hair into the pouch to join the other fetuses which now could be seen to have made the trip without one having been able to observe them. Unerringly the embryo traveled by its own efforts. Without any effort on the mother's part, other than to free it of liquid on its first emergence into the world, this twelve and three-quarter-day-old embryo, in appearance more like a worm than a mammal, is able, immediately upon its release from its liquid medium, to crawl a full three inches over difficult terrain. Indeed, it can do more; after it has arrived at the pouch, it is able to find a nipple amid a forest of hair. This it must find or perish."

Birth is rapid. Harold C. Reynolds saw one opossum deliver four young in eight minutes, another bear fifteen young in two and a half minutes, and a third produce twenty-five in less than five minutes. The speed with which these young move is remarkable. One is on record as having traveled from the vaginal orifice to the pouch in sixteen and one-half seconds. Because of the female's position at the time of parturition, the distance each young must travel is equal to three or four times its own length.

Unless the young start in the right direction, they are often doomed. Frequently several emerge together, grab one another, and fall to the ground. Of fifty-seven young born to four females, Reynolds noted that only 60 per cent managed to reach the pouch.

The mother has prepared the pouch well for the reception of the young. A thorough cleaning of the marsupium enables them to grasp the tiny nipples easily. The nipples lengthen and enlarge in the circular mouth openings. A firm attachment results, insuring the growing youngsters of both sustenance and anchors that resist strong efforts to remove them from their haven. To detach a young opossum from the pouch, without damage to itself or the teat, requires slow and careful twisting. It seems unlikely, therefore, that a young animal can be lost by other than unnatural means during its early pouch life.

During this early postnatal life, the youngster uses its strong cheek muscles to draw in milk, which, contrary to popular belief, is not forced into the youngster. Nor do the tongue and cheeks grow fast to the nipple. The opossum nurses in the same fashion as do other mammals.

The pouch undergoes marked changes during its occupation. In a virgin

AT TWELVE WEEKS, these opossums are totally independent of mother's pouch and wait in lair while she seeks food.

female, the chamber is lined with soft, cottony, white fur and tiny white teats. The pouch of a female that has produced young has scant, rusty-colored fur and enlarged teats. There are usually thirteen teats, occasionally more, sometimes less. I have examined individuals with fourteen teats, each of which was occupied by a baby. The nipples are arranged in a horseshoe pattern, the odd teat occurring in the center of the pouch. It is evident that when the litter outnumbers the teats, which is usual, all but thirteen young die. Often, not all teats are occupied.

Growth progresses slowly. Two months will pass before the mouse-sized babies can open wide their mouths and eyes. Even before this, the young may have left the pouch, but they are still anchored to it by greatly elongated nipples. Considerable variation in development occurs among litter mates, thus no hard and fast rule can be laid down as to the growth sequence. As the young increase in size, the pouch stretches to

An adept climber, opossum mounts a tree while bearing young on back. The animal is usually earthbound, however, climbing solely for food or sanctuary.

Grabbing loose fur, young ride on mother's back when she forages. Large litter may make walking hard for her.

accommodate the greater burden. Provided with a prominent sphincter muscle, the mouth of the pouch can be closed or opened at the will of the mother. When the mouth of the pouch is closed, one may wonder how the youngsters can survive in the foul chamber. But they do thrive, although the carbon dioxide concentration may reach 6 per cent.

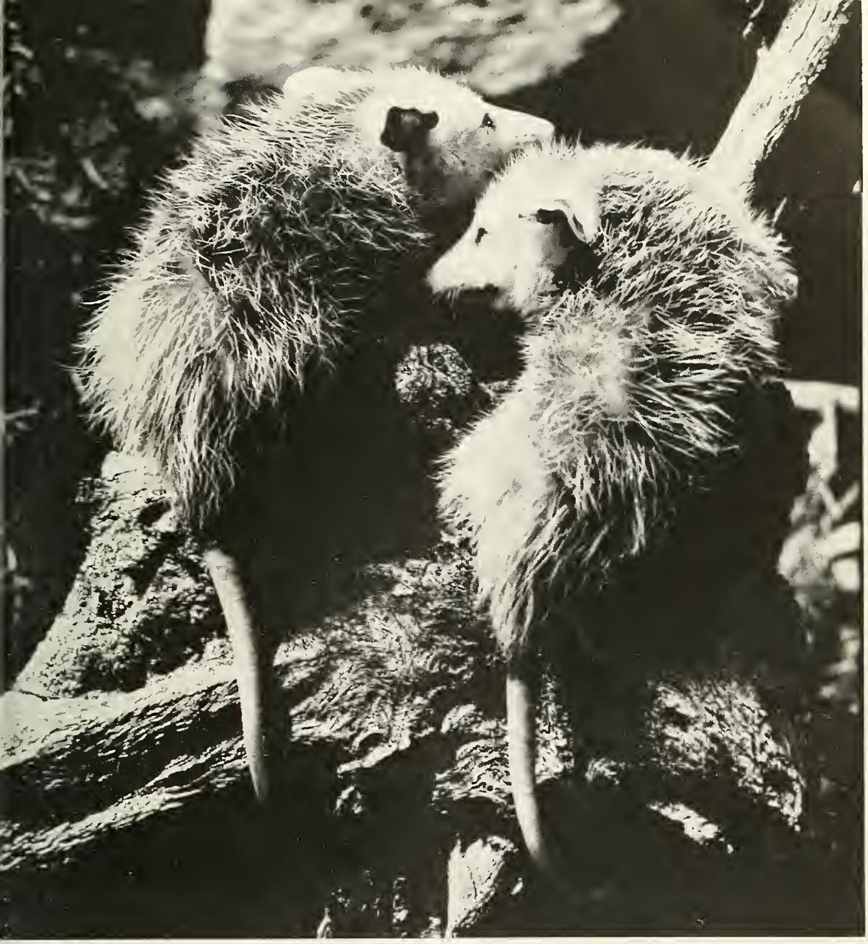
When they are ten weeks old, the youngsters, now the size of small rats, are able to run and climb with agility. They leave the pouch while the mother sleeps in the den, to huddle against one another or drowse alone. During the mother's nocturnal journeys, the young may clamber on her back, securing a purchase in the loose fur, or they may repair to the pouch until they are twelve weeks old. If the mother is burdened with a large litter at this period, she is rendered almost incapable of walking. Weaning is accomplished between the thirteenth and the fourteenth weeks. The young opossum, now the size of a Norway rat, is ready for an independent life.

Most females produce two litters in a season; indeed, a brood may occupy the pouch within two weeks after it has been freed of an earlier litter. One wonders how the enormously enlarged teats, still distended and drawn out from a previous nursing, can serve the tiny mouths of a fresh brood. But regression has taken place in the size of the nipple tip, and it fits well into the newborn's maw.

In their new world of forest, swale, and brushland, the youngsters lead a solitary existence, sleeping in a deserted burrow, drain tile, or stump during the day and venturing forth as the evening shadows lengthen. In these retreats, a bulky nest of dried leaves is prepared. This bedding is collected in singular fashion. Gathering up a mouthful of leaves, the opossum passes it back under the arched body with its forefeet. The tail is curved beneath the body and the material pushed into the resultant crook, where it is firmly packed by alternate thrusts of the hind feet. About six or eight mouthfuls are handled in this way, and the action is so rapid that the leaves are in almost constant motion from the time they are picked up from the ground until they are secured in the coiled tail. The opossum then carries them off to use as lining for its lair.

The tail may also act as a fifth hand while the animal crawls among vines and tree limbs. The tail tip curls loosely about them, then releases them as the animal moves along. It thus acts as a safeguard should the opossum lose its footing, momentarily checking a possible fall until a secure hold is regained. However, it is most unusual

Young stay near nest for a few days before striking out on their own. Other opossums in the four-month-old litter already live alone. Born merely seconds or minutes apart, brood mates may differ markedly in growth at a given time.



Naked tail and ears of opossum are quite susceptible to frostbite. Strangely, these frozen regions do not develop infections, and losing the tips of the ears and a portion of tail does not appear to affect the animal functionally.

to see an opossum hang by its tail; this position can be maintained for only a very limited time.

Opossums do not wander far from their nests. The home range of an individual may encompass an area not exceeding ten or fifteen acres. By following the distinctive tracks in the snow, we know that some individuals are content with a home range of six or seven acres, while others may wander far more widely. Males occupy a larger territory than do the females.

In the northern part of their range, opossums may sleep away the severest winter spells of sub-zero weather. The opossum is not a hibernator like the woodchuck and does not have the ability to fast for prolonged spells, as do the skunk and raccoon, when severe weather approaches. It is thus abroad in frigid spells, and this exposure can mean frostbite to the naked ears and tail. As a result, many animals lose their ear tips and the distal portion of the tail. The partial loss of these structures does not appear to harm the animal and presumably has no basically damaging effect.

The opossum has often been labeled a scavenger, an opprobrious creature that subsists largely on garbage. This notion has been fostered by the frequency of the opossum's appearance near human habitations. But stomach analysis of many hundreds of these animals discloses that the opossum's feeding habits are not unlike those of other predatory animals of comparable size. Securing natural foods, particularly during cold months, is difficult, but with the approach of warm weather a varied menu becomes available. Late summer and fall are the periods of gluttony, for there is an abundance of grasshoppers, crickets, ripened fruits, and a swarming horde of small vertebrates. Like many other animals, the 'possum takes the food that is most available, showing little predilection for specific items.

EXAMINATION of 161 stomachs of New York opossums indicated their diet throughout the year. Insects and small mammals, principally field mice and shrews, each occurred in more than two-fifths of the stomachs, while green vegetation and fruits both had been taken by more than a third of the animals. Earthworms and amphibians were eaten by one-fourth of the opossums that were examined. Surprisingly, 10 per cent of the stomachs contained toad remains. This amphibian possesses large toxic parotid glands, distasteful to some animals, but not a deterrent to the opossum. Birds, snails, reptiles, grains, and small arthropods other than insects are also eaten.

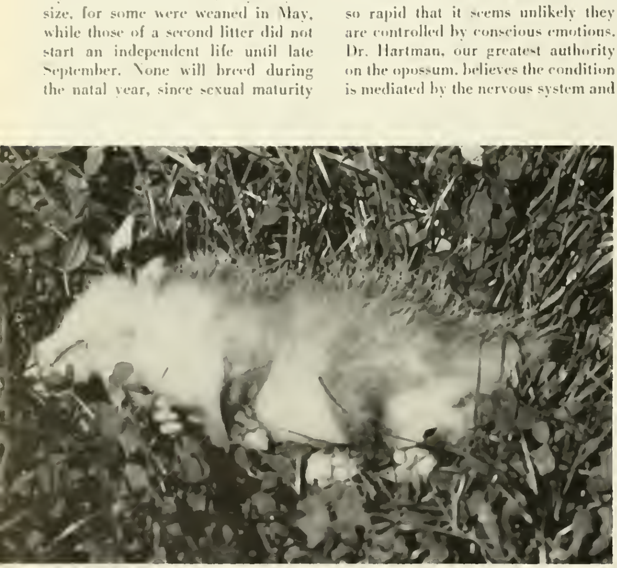
As their first winter approaches, the young opossums develop a substantial layer of fat. To be sure, they vary in size, for some were weaned in May, while those of a second litter did not start an independent life until late September. None will breed during the natal year, since sexual maturity is not attained until a year after birth.

Opossums are short-lived creatures, few surviving beyond two years (the life span of most mammals is generally in proportion to their size). Therefore, a high reproductive potential is essential to maintain the 'possum population. This is reflected in the large number born in a single season. The winter population consists of six or seven young opossums to one adult.

The well-known habit of "playing 'possum" is by no means restricted to the opossum. Foxes, wild dogs, and other mammals share this trait, as do insects, toads, lizards, and many other creatures. A classic example is the harmless spreading adder, or hog-nosed snake. We have often seen this reptile, come upon suddenly and touched with a stick, flip over on its back, open its jaws, and lie immobile for several minutes until the threat has passed. The opossum exhibits this trait to a high degree, although not all the individuals assume the deathlike trance. The animal lies on its side, the eyes closed and the lolling tongue extruded between half-open jaws. It will maintain this attitude for several minutes. While some believe this cataleptic state can be attributed to fear, the reactions to a sudden stimulus are so rapid that it seems unlikely they are controlled by conscious emotions. Dr. Hartman, our greatest authority on the opossum, believes the condition is mediated by the nervous system and is a result of changes in the brain and ventral ganglia. He proposes that in the nerve centers there are certain labile substances that are harmless in themselves but that serve as precursors to substances that paralyze. Hartman believes that the stimulus of a touch causes nerve impulses to act like percussion caps setting off a charge. The resultant new substances so stimulate the motor nerve fibers that all of the muscles on both sides of the joints contract, causing a stiffening of the limbs. As the paralyzing substances are diffused from the nerve cells, the paralyzed animal recovers. Certainly death-feigning has survival value, and it is surprising that this trait does not occur more frequently in wild animals.

IN assessing the economic worth of a wild animal, one must explore many facets of its life. The relation of the animal to man and to other animals, its value as a fur bearer, its role in the transmission of disease, and a number of other factors determine the economic role it plays. Some predators are of considerable value when they occur on wild lands, for there they provide fur and flesh for man, act in a measure as a control over species injurious to agriculture, and have certain intangible values, not the least of which is an aesthetic one. On the other hand, efforts must be made to control a species that preys on livestock and transmits disease to man and beast.

The economic value of the opossum to man is not easily measured. It has relatively few valuable qualities, yet it is certainly not the major pest that sportsmen and some agriculturists consider it to be. It seldom takes poultry, nor are game species an important item in its menu. The prime pelt is used to trim cloth coats, and thousands of skins are exported to the European market, where they are made into whole coats. As for the famed "'possum and sweet 'taters," my advice, after eating several of these beasts, is to throw away the 'possum and eat the 'taters. In any case, the opossum, a biological curiosity, provides an interesting subject for anatomical, physiological, and behavioral research for the naturalist. We are indeed fortunate to have it in our native fauna.



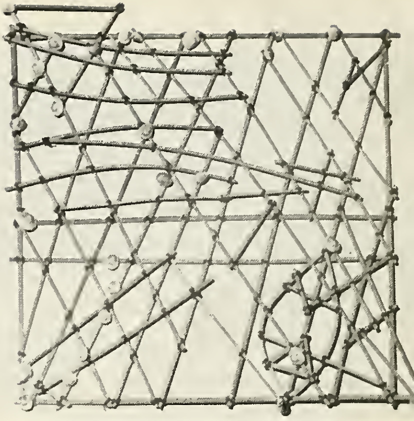
OPOSSUM REACTS to threat by falling into a temporary cataleptic state that lasts for several minutes. Many other living creatures also "play 'possum."

WHEN CORNERED, opossum bares teeth, showing its large canines. Relatively few predators threaten this animal.

3y Dunung and Bouj

ater movements, stick charts, and agic help natives stay on course

By John H. Brandt



Navigational chart of sticks, called *rebelib*, uses cowries to mark islands.

ɪhe young boy lying in the bottom of the outrigger canoe seemed ɔ in thought. His eyes were closed t. An old man with wrinkled brown ı and a flower over one ear squatted he bow and watched him intently. ther said a word. Suddenly the boy the canoe rock in a slightly dif- ·nt fashion and whispered to the man that the course bearing should nore to starboard. Several adjust- ıts in direction followed during the t few hours. Always the course was ed on the feel of the wave pattern. ɪn the ocean lapped against the bow h a new sound. The boy, still lying his back and staring up at the clear ɔical sky. smiled and triumphantly l, "We've made it." They both ɔd up and soon the first coconut m fronds appeared on the horizon. other ten miles and they stepped ore on the white sand of an isolated rshall Island atoll.

They were not castaways, since the man, a Marshallese navigation in- ıctor, had known all along where d was to be found. For the boy it s the first field trial to determine v well he had learned his navigation sons. This test of skill, many miles m sight of land, would be repeated eral times. Variations would be de- ed, and some tests would be on ·k, starless nights. The training uld be thorough, since the lives of the navigator and his shipmates would depend on it. These lessons are still taught, in this day of the compass and navigation chart, to many Marshallese boys on lonely South Pacific atolls.

Many forms of navigation are known to the Marshallese, and although some are insufficiently based in fact and are often fallible, it surprises researchers how often the small island canoes reach their destinations.

Navigation was a well-developed art in the Micronesia of old and still is today. The small boy, who may never sail to a place of any consequence, knows the names of the stars, can tell weather signs, and reads the many illusive messages of the sea.

The Marshallese have devised a system of instruction based on a chart made of sticks bound with cord in an apparently abstract crisscross fashion and dotted with cowrie shells at strategic locations. The sticks are cut from roots of the pandanus tree and are known as *okar* or *kenaj*. They are tied with string of hibiscus bark, *aramai*, and may be straight or curved. The finished chart is called a *metto* if it covers a group of islands, and *rebelib* if it comprises the whole archipelago. Such charts have been made of the entire Ratak and Ralik chains in the Marshall Island Archipelago.

Basic instruction is given on a simplified, geometrically balanced chart called a *mettang*. On it the student learns the names of all the major waves, currents, and ocean swells. In early times the atolls of Namorik and Ebon were noted for their navigators, and the *Leadakdak* clan became known for its talents in this field.

In the Marshall Islands, the strongest ocean swell, or *dunung*, is called *no-en-rear*. It comes from the east-northeast. Opposing swells are identified by other points of the compass. The weakest is the western *dunung*, also called the *kaelib*, or *kaletakrilik*, which can be felt and identified by only the most skilled navigators. In the southern Marshalls a powerful south or southeast swell, the *bundockerik*, is recognized. The northern *dunung*, or *bundockeing*, is evident only in the northernmost islands.

As these waves approach an island, they bend or fold around the land mass. Since the opposing wave will do the same thing, a wave ridge is built up at the point where the two meet. This is known as *bouj* and is the nodal point upon which the atoll dwellers depend to lead them to land. By being constantly alert and watching the pattern of the clashing *dunung* the navigator can proceed toward the point that has caused this phenomenon. The small cowries tied to the *metto* usually indicate these places. Such curving of waves may be caused by shallow or submerged reefs. Consequently, in strange waters, a navigator can be misled. The Marshallese say that when the first wave ridge is found, one need only follow it as one follows the roots of a pandanus tree, until it leads to the main trunk. This system

ɪtrigger canoe runs with wind near monuito Atoll, in Caroline Islands.

Boys learn navigation from Marshall Islander, who is teaching them to use stick chart. Such charts may apply to island group or to whole archipelago.

Native of Yap inspects bow of canoe before starting on sailing trip. Only in the central Caroline Islands are sailing canoes still used for lengthy voyages.

is indeed known as *okar*, the root which will lead toward the island.

Waves also bounce back from an island, and at various points they have names. These produce smaller *bouj* which a less-than-expert navigator may misinterpret and follow. Unless good fortune brings the canoe within sigh of the palms, the island may be missed entirely. Fully cognizant of the shortcomings of these systems, the Marshallese rely much on magic.

In the central Caroline Islands navigators carry special arm bags woven of sennit cord, with a small charm of seeds and leaves attached to enable the men to retain the intricacies of marine navigation. When the bag is left at home, the charm is attached to the navigator's wrist as insurance that studies of past years will not be forgotten in time of need.

The Micronesians of the Woleai area in the central Carolines and the adjacent islands wood-carve an idol with two heads and legs made of sting ray tails. Always faced with the possibility of encountering savage tropical storms while at sea in frail canoes, the navigators have created the charm as a form of storm insurance. They also sing chants to appease the storm gods and to request that in case of bad weather the canoe be spared. It seems that a navigator's prayer invariably begins and ends with the words, "You are so great and I am so small," and so must the crew of a small sailing canoe often feel when far from land.

Today Micronesian marine navigation in canoes is practiced on a significant scale only in the islands between Truk and Yap. Elsewhere the natives rely on larger boats and copra ships for transportation. Although the Marshallese are still expert in wave interpretation and the *mettang* is vital to their instruction, they themselves now sail in ketches and the day of the ocean-going canoe is a memory.

Central Caroline Islanders, in their huge red and black outriggers, however, will sail hundreds of miles to get cigarettes, to attend a ceremony, or just to visit friends. One concession they make to modern science is their acceptance of the compass, often obtained from Japanese or American aircraft downed in World War II.

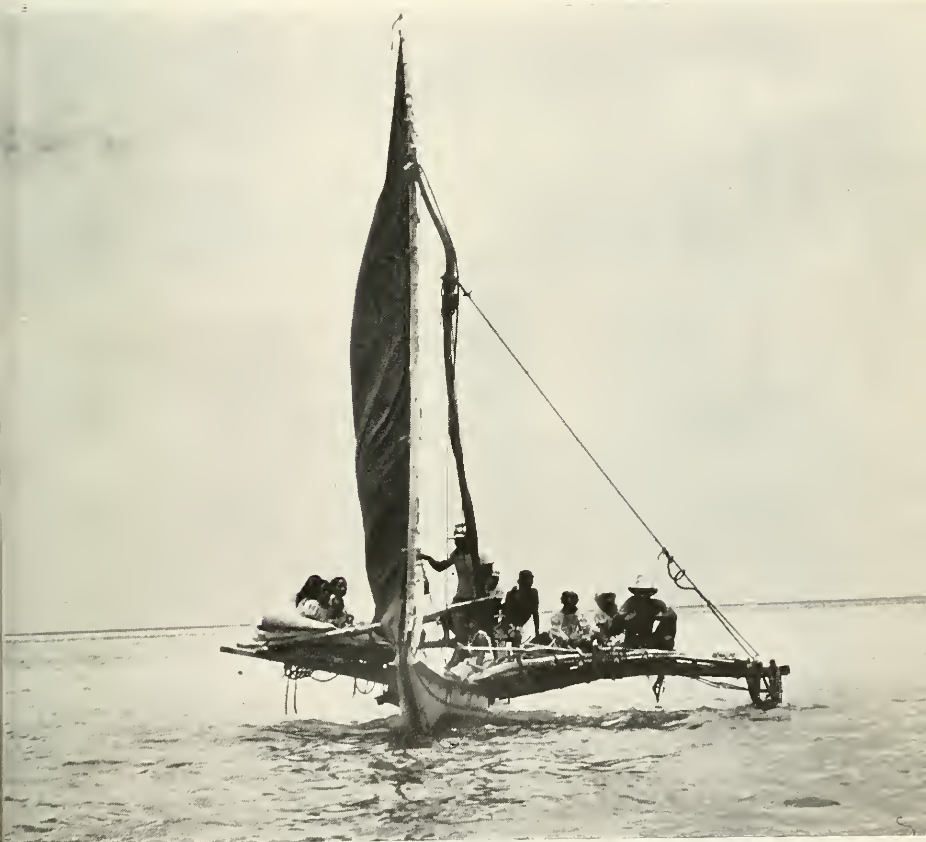
Navigation lore has always been a closely guarded secret. The full story of Marshallese stick charts will possibly never be known, since the Marshallese navigators—in rare cases wo-

—will not divulge all of their ts. Stick charts were often devised y to refresh a person's memory. ey were not maps in the truest e. Great variations occur, since navigators of the same school t devise two dissimilar stick charts he same route, because each would to remind himself of different cts of the course.

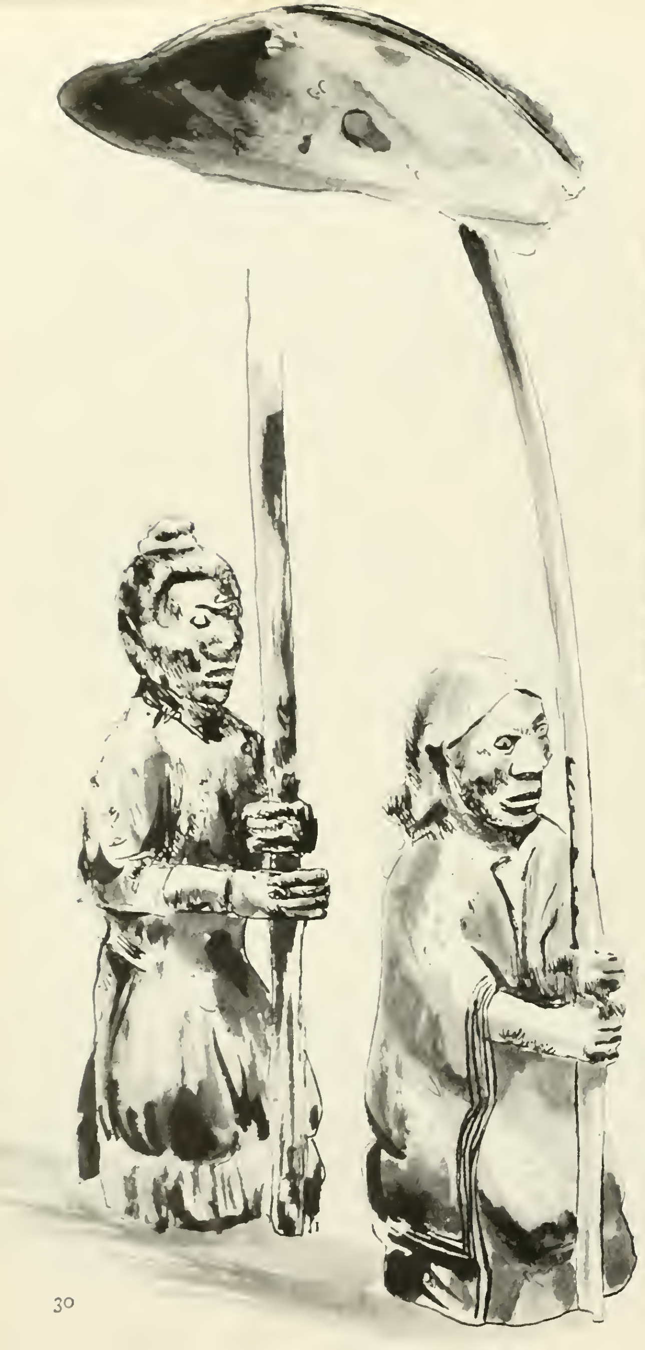
IDE is another important factor n withholding navigation secrets outsiders. The person who can r vast distances on the open sea small canoe and deliver his crew y is granted considerable prestige in his community. At times, while traveling in the Marshall Islands, one sees canoes that are obviously lost at sea. Any suggestion that the craft be "rescued" or taken in tow is construed as an insult to the navigator, who seems to work on the assumption that his island destination may be lost, but he certainly is not.

Canoes usually travel in pairs in case accident befalls one or the other. It is often said that as long as the canoe holds together and the outrigger is not damaged, any storm can be survived. When waves are sufficiently powerful to cause concern for the outrigger, the canoe is allowed to fill with water. Then, floating awash, it can ride out the worst storms, with the six- to ten-man crew tied to the craft or clinging to it until the storm subsides.

WHEN the danger is past, the sail is hoisted and wind pressure forces the canoe to plane to the surface. Everyone bails frantically until the canoe is dry, or at least as dry as a seagoing canoe can be. Then, confidently following the age-old teachings of the navigator, the crew sets sail, following the waves, the stars, and the sea birds. Chants are sung and magic is made. Surely the island they seek is just over the horizon, and usually it is.

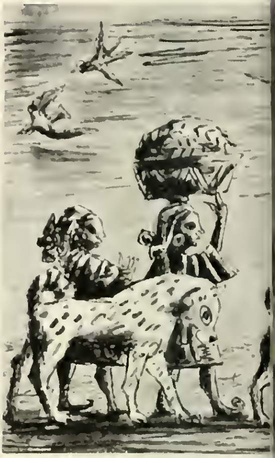


ILING CRAFT is capable of carrying surprisingly heavy d. The complement normally consists of six to ten men, but eleven persons are visible aboard the outrigger canoe shown here. For safety, canoes make long voyages in pairs.



Cache

Art from ancient

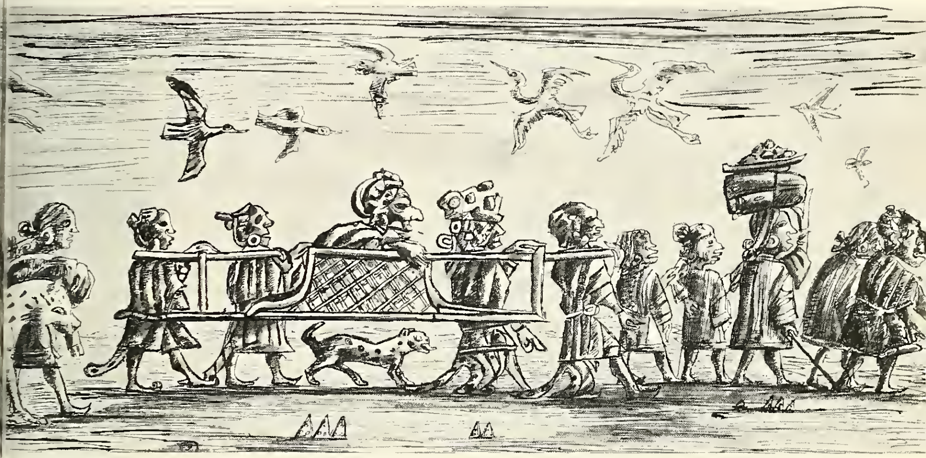


Human and canine figure with litter, incised on the surfac of a Shih-chai-shan drum, may possibl represent a funeral procession

Non-Sinitic features of bronze, two-foot-high women, one of whom carries a parasol, show mixed ethnolog that existed in Yunnan in Han times.

t Stone-fortress-hill

en may help to explain obscurities in Far Eastern history



By John F. Haskins Illustrations by Hans Guggenheim

ROPEAN GEOGRAPHERS of the second century A.D. showed two major realms on their maps of the extreme . One was the silk-producing land of the Seres, which d be reached only after a long and arduous journey ss the Eurasian steppe and through Central Asia. The r was Sinum (or Thinum), inhabited by the Sines, h was reached by sea through the Indian Ocean, the of Bengal, and the Gulf of Tonkin. Nearly a millenn and a half were to pass before Europeans realized the two regions were actually the northern and south- parts of the same country—China.

his concept of two Chinas was not, however, exclusively tern in origin; Chinese themselves made the distinc- . For centuries northern Chinese regarded that part he empire south of the Yangtze River as "foreign."

his feeling persisted even after the country's unifica- under its first emperor, Ch'in Shih Huang-ti, in the d century B.C., and its later expansion under the early n, in the third and second centuries B.C. Among the ls and peoples acquired through expansion in the latter iod was the kingdom of Tien, whose chieftain was ng the most powerful in the southwest, and whose ital was K'un-ming, still the capital of Yunnan Province.

Vestern literature abounds with stories of the travels dventurers who set out for the Far East and returned Europe with tales of the wonderful and the strange. nese, whose adventures are no less remarkable, and who traveled from China to the West, are not so well known in the Occident. One of them, however, is still very famous in China. His name was Chang Ch'ien, and he was said to have "pierced the void," for he traveled from what is today Sian in Shensi Province, to the kingdom of Bactria (modern Afghanistan), an air distance of about 2,700 miles. Chang Ch'ien was a nobleman who, about 137 B.C., left the court of the Han emperor Wu-Ti (140—87 B.C.) and traveled westward to find allies to aid in a war against a Hunnish tribe that was ravaging the frontiers of northern China. He failed in this, but instead carried to his emperor news of a possible southern trade route through India to the Western world. Emperor Wu-Ti agreed to Chang Ch'ien's proposal that an attempt be made to find this route, and, according to Ssu-ma Ch'ien, father of Chinese history, "ordered ambassadors to go forth to the barbarians in the west and in the southwest to find the way to the kingdom of India." As the traveling party entered the province of Yunnan, they were met by Ch'ang Ch'iang, king of Tien, who invited them to remain in his capital while he himself sent out a mission to continue the search. The route to India was not found, but after spending more than a year in Tien, the party returned to Wu-Ti with high praise for the country's greatness, and advised "friendship and annexation." The Emperor listened, and eventually bent his efforts toward expanding his empire.

The period of annexation by the Han was one of war and rebellion, and by 109 B.C. the dynasty had conquered most of southern China. Many of the southern leaders were massacred and the rest flocked to the Han banner. Only Ch'ang Ch'iang withheld his surrender. The Emperor massed his armies against the Tien and evidently forced Ch'ang to make peace. The outcome was recorded about 99 B.C. by Ssu-ma Ch'ien in the *Shih Chi (The Book of History)*.

". . . The King of the Tien [Ch'ang Ch'iang] mended his ways and was not punished. He was separated from his allies and his realm brought to submission. The King was given a golden seal and allowed to govern his people as before. . . . Thus, the villages of Tien continue to enjoy the highest favor from the Son of Heaven. . . ."

ONLY recently has evidence of that once-powerful kingdom of Tien been brought to light. A series of excavations, begun in 1952, was carried out by the Yunnan branch of the Chinese Academy of Science, through its Institute of Archeological Research. Remains of Tien were found by excavating a cemetery at Shih-chai-shan ("stone-fortress-hill"), thirty miles south-southwest of K'un-ming. The site is on a fortress-like bluff on the shore of Lake Tien-ch'ih, the largest body of water in southwest China.

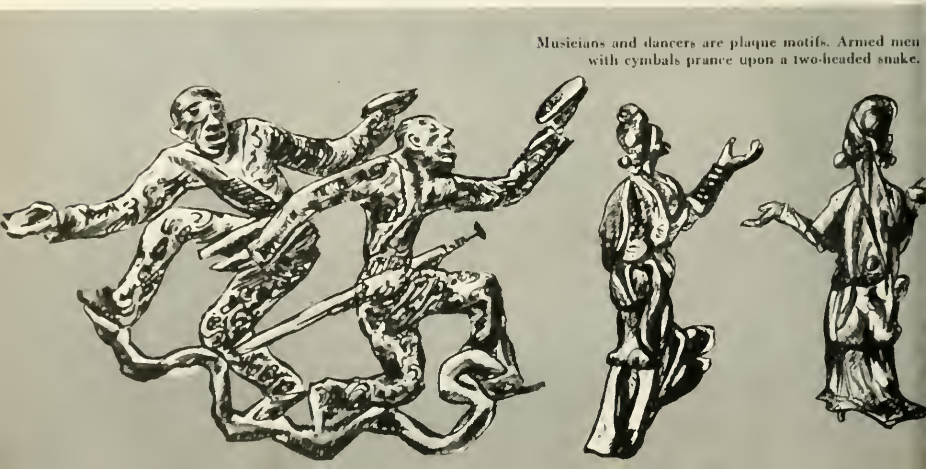
This discovery may be one of the most important in China since the excavation at An-yang in 1928, which supplied evidence of the Shang dynasty (*ca.* 1766 to 1122 B.C.). Certainly it is one of the most spectacular. Materials from tombs at Shih-chai-shan are unlike anything else ever found in China, and they may eventually do much to explain both the art of the early Han dynasty (*ca.* 206 B.C. – A.D. 9) and the Đông-so'n culture of Vietnam.

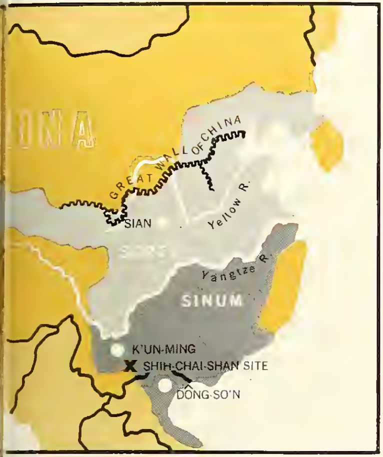
Modern studies and archeological investigations postulate six basic backgrounds or cultural groups that were very strong factors in the development of Chinese culture: the northern, or "proto-Tungusic"; the northwestern, or "proto-Turkic"; the western, or "proto-Tibetan"; and three more cultures in the south, grouped together as "proto-Thai." Evidences of many of these influences were found at Shih-chai-shan. The proto-Thai cultures were also called the Yüeh, and included a people that occupied southeast China during the late Chou period (*ca.* 480–221 B.C.). The Yüeh were maritime and fluvial, with Indonesian and oceanic affinities. They held boat races (which survive in the later Chinese "Dragon-boat Festivals"), had dragon-myths, worshiped serpents (possibly derived from the serpent water spirits of pre-Vedic India) and venerated sacred mountains (another important characteristic of later China). The southern or Yüeh influence was characterized by wet rice agriculture (the "rice eaters" of the south are always distinguished from the "wheat eaters" of the north), irrigation and slope terracing, ancestor worship, pig sacrifices, and the domestication of the water buffalo. In fact, a great deal that today seems typically Chinese may be traced to the peoples of the southeast, who were not actually part of the culture today associated with China per se. The importance of

China, after its expansion under the Han dynasty, is shown in shades of gray. The Great Wall made up part of the northern boundary of North China (Seres), which contained the Han capital of Sian. Yangtze River formed the boundary with South China (Sinum).

ALEXANDRIA

Musicians and dancers are plaque motifs. Armed men with cymbals prance upon a two-headed snake.





of these atypical characteristics may be seen in the
ze art from the tombs excavated at Shih-chai-shan.

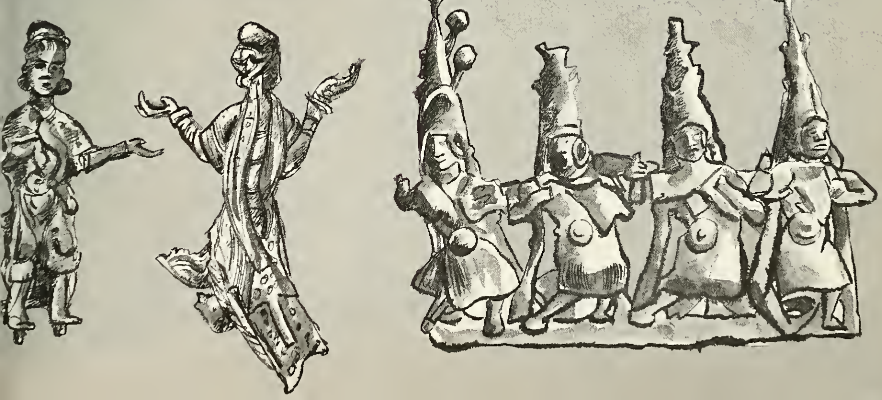
rth of the Yüeh people, along the Yangtze Valley and
ying most of what is today Anhui. Hunan, and Hupei
nces, was the powerful state of Ch'u. Its brilliant
art, which included lacquer ware, metal work in
ze, gold and silver, excellent ceramics, and the oldest
ainting in China, is well known from many excava-
, some of which are recent. Traces of the Ch'u were
found at Shih-chai-shan, especially in some types of
ons. This is not surprising, for a Ch'u general, Chuang
o—himself a descendant of the Ch'u royal family—
ded a long line of Tien kings, one of whom was Ch'ang
ng. It is quite likely that the necropolis at Shih-chai-
may be their royal burial ground.

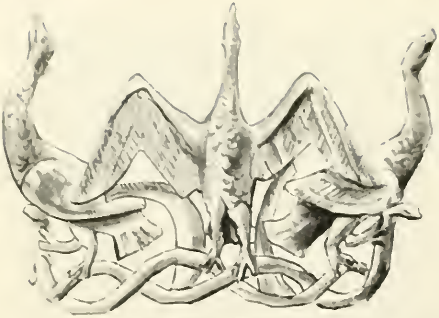
Some characteristics of the Tien materials seem, however, to link the site with the nomads of Central Asia, and still others show affinities with the bronze culture of Dông-so'n in central Vietnam, a type site uncovered at the turn of this century. Dông-so'n was characterized by the presence of many bronze drums of a distinctive pinch-waisted shape, which were later found at other locations throughout Asia, and which are known as the Dông-so'n type. Some of the drums from Shih-chai-shan are similar to those from Dông-so'n in both shape and incised decor. At least one such drum had previously been reported from Yunnan.

Among the wealth of influences embodied in Tien art, yet another remains to be mentioned—the bronze animal style decorations that distinguish the plaques, the belt buckles, dress ornaments, and so on that were used by these people. It is a flat style, in which the form of an animal is forced into the shape of the object it decorates. The animal style of art that appears on some plaques from Shih-chai-shan ranges from vivid realism, through decorative abstraction, to the nearly comic. Many pieces show animals in combat, and bring to mind the famous "animal style" art of the Eurasian steppe district as seen in the "gold treasure of Peter the Great," now in the State Hermitage Museum, Leningrad (see NATURAL HISTORY, October, 1960). All of the bronzes from Shih-chai-shan, particularly those in the realistic style, are even more lifelike than are their Siberian counterparts. However, it is just possible that tribes from the Tibeto-Central Asian borders of China may have wandered down into the southwest, bringing with them an art style that influenced the native products. Here, too, are traces of Indian art.

During their years of work, the excavators opened twenty graves at the site, and numbered them M-3 through M-22. It is believed that all of the tombs belong to the Western Han period (*ca.* 206 B.C.—A.D. 9), although some objects found in them might reflect styles of preceding periods. Some graves were "poor" in materials, while others were "rich." Date of burial and rank of the person entombed may have some bearing on this situation, but the earlier tombs tended to be smaller. However, the real basis for a chronology was provided by seals (one of gold, all

four women pirouette with outstretched arms.
right, men in pointed caps sway to rhythm.



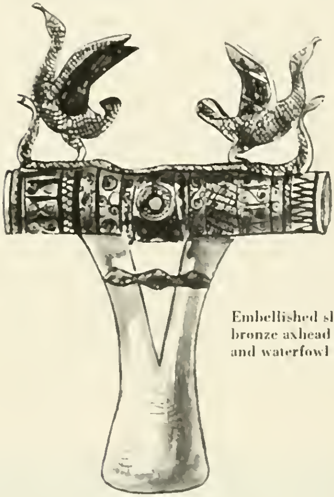


Intertwined snakes, seen here as a base for peacocks, are prominent in this art form, and may symbolize serpent worship.

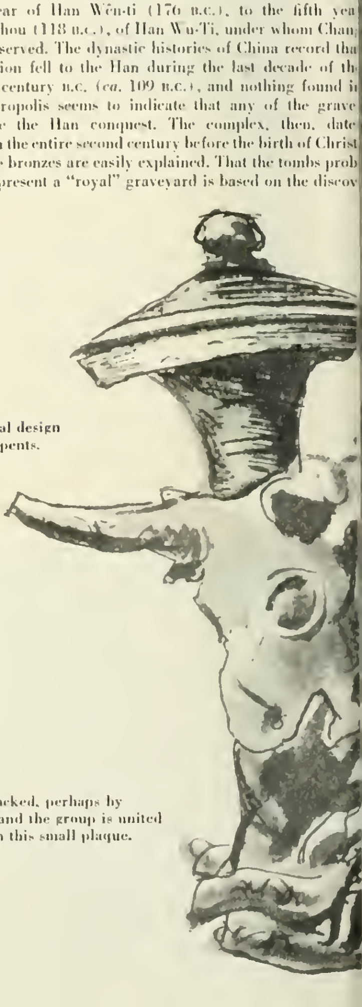
the others of bronze) of known historical figures or event Chinese coins bearing dates of the reign-years of Ha emperors, Han-type mirrors with inscriptions, Chines weapons, and other objects of Chinese manufacture, a of which could be dated by comparison with articles o the same type from other areas.

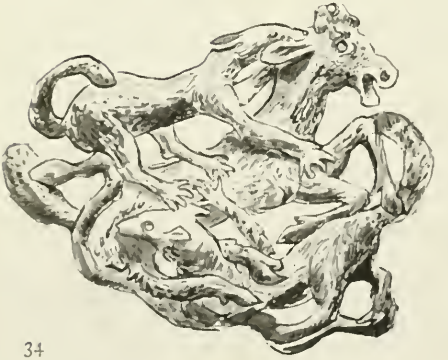
The tombs fell into four stylistic categories, which wer found to fit three major chronological subdivisions Graves of Type I were early (*ca.* 206–176 B.C.), whil those of Type IV are believed to be late (*ca.* 118–109 B.C.) The middle group, Type II (*ca.* 176–118 B.C.), with th largest number of graves, and Type III (*ca.* 150 B.C. could, however, be dated with more precision, since grave of Type II contained coins that ranged in date from th fifth year of Han Wên-ti (176 B.C.), to the fifth yea Yüan-Shou (118 B.C.), of Han Wu-Ti, under whom Chan Ch'ien served. The dynastic histories of China record tha the region fell to the Han during the last decade of th second century B.C. (*ca.* 109 B.C.), and nothing found i the necropolis seems to indicate that any of the grave postdate the Han conquest. The complex, then, date through the entire second century before the birth of Christ

Some bronzes are easily explained. That the tombs probably represent a "royal" graveyard is based on the discov



Embellished shafting on a bronze axhead has abstract spiral design and waterfowl supported by serpents.





Deer is attacked, perhaps by wild dogs, and the group is united by snake on this small plaque.

ery in one tomb of a gold seal, inscribed in Chinese characters with the phrase: "King of Tien." This is a third style grave (*ca.* 150—109 B.C.), and the seal may be that mentioned in *The Book of History* as having been presented to the Tien king Ch'ang Ch'iang by Han Wu-Ti in 109 B.C.

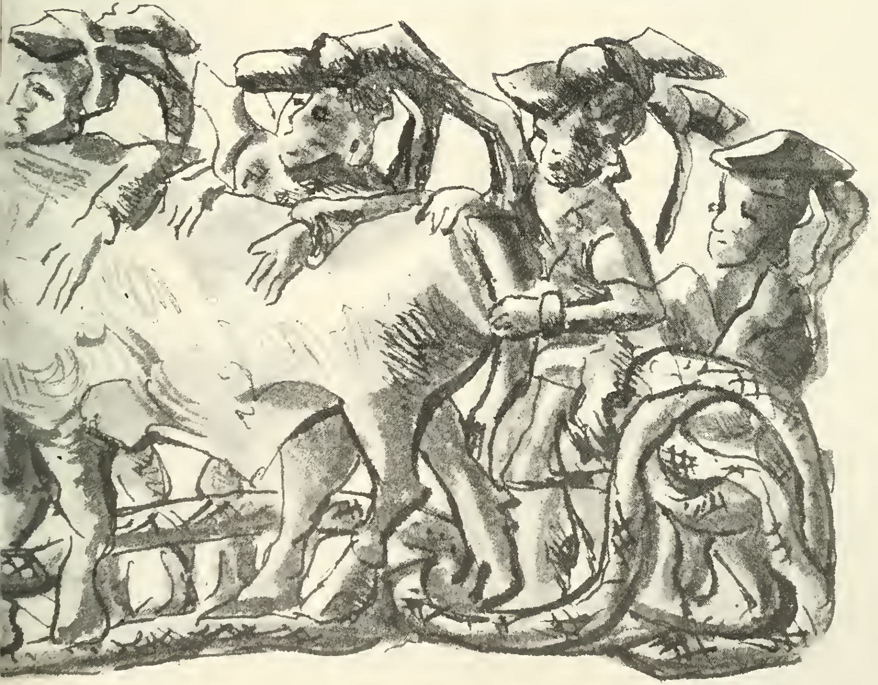
However, many weapons, vessels, and drums are enigmatic both in form and in the meaning of their decoration. Much of the material seems to confirm a theory, once proposed by Dr. Robert Heine-Geldern, that a connection existed between southwest China, southeast Asia, and the Transcaucasian (or even more remote) west. If his theory is correct, this link occurred about the turn of the first millennium B.C., before the period of the Tien material.

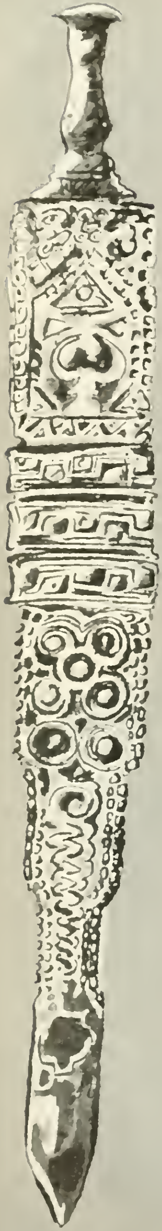
Aside from the complex outside influences already mentioned, the art from Shih-chai-shan exhibited a vigorous native style. This was characterized by representations of human sacrifice, some form of snake worship, bull fights, and possibly bull worship, all presented in graphic form in a series of skillfully cast pieces of most unusual design. These particular bronzes may prove to be among the earliest in China that were made by the cire-perdu, or "lost wax" process, as it is improbable that the more complex objects could have been cast in piece molds. It also seems sure that no barbarian culture would have realistically rendered scenes of human sacrifice, such as those on ceremonial vessels. Some of the objects may have been the work of Tien artisans, but there must have been a strong artistic pressure from a higher culture to have made them possible. The closest one, of course, was the empire of Han. That some trade existed is obvious from the amount of Chinese material in the tombs.

Among the animal motifs that appear most often in the bronzes is the bull, whose significance in Tien culture is not yet understood. One of the most striking examples of its use is on a ten-inch-high vessel (pp. 36-37). Four bulls march around the rim, and a rider seems to be trying to bed them down for the night. The scene looks like something from the American "Wild West" of the 1880's, an effect heightened by the long horns on the cattle. Similar "animal parades" that are just as puzzling decorate bronzes taken from the Ili River district in the northern T'ien-shan, a mountain range of Soviet Central Asia.

Another and possibly more significant appearance of the bulls is on a pair of small plaques, each about three and a half inches long, with scenes that would be more appropriate to *Carmen* than to a Chinese bronze. In both cases a bull is entering a ring while an audience apparently cheers the "matador." There are many references to "bull fighters" in Han literature, and the bull ritual, as depicted on Honan reliefs of the period, has been studied.

Significance of the bull in Tien culture is unknown, although it appears often on the bronzes. Here, accompanied by human figures and snake, it is led to an altar.





The snake is another recurring motif, and may indicate serpent worship —perhaps the reflection of an influence from Dravidian India. One reptile motif is that of a deer being attacked by wild beasts (perhaps wild dogs), while the whole composition of struggling animals is united by a twisted pair of snakes biting victor and victim alike. This detailed plaque, which was perhaps an ornament designed to be worn on clothing, is about six and a half inches long and five and a quarter inches high. Another plaque about six inches in diameter has an arabesque of snakes and three peacocks, all cast in openwork, while still another depicts what is probably a prisoner being devoured by large serpents before the tribal chieftainess (or a statue of a goddess). The snake symbol probably represented some phase of a local cult, and further indicates the importance of the serpent as the prototype of the southern "Dragon-boat Festival."

Action scenes appear often on the bronzes. One of the liveliest is a plaque of two armed men dancing and beating cymbals while a huge, two-headed snake nips at their feet (p. 32). The dancing men are explained by references to the "wild songs and dances of the guerilla fighters from the southern state of Pa." (an ancient name for Ch'ung-king) that occur in early Chinese literature. Bronzes such as this, with human figures, have historical importance, and will provide a subject for anthropological and ethnological studies for many years.

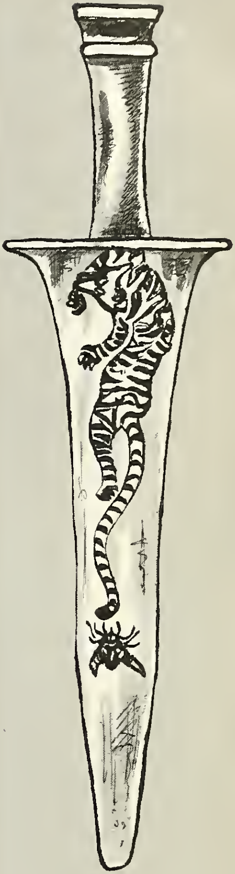
Some of the human figures are less easy to identify. One plaque shows a group of musicians swaying in a dance and wearing tall, pointed caps. Pirouetting girls blowing on instruments made from gourds decorate several miniature bronzes, each about three inches tall. (Gourd-shaped whistles of bronze were also found in some tombs.) Perhaps the most unusual of the human figures are a group of full-round bronzes that depict kneeling servant women, of whom the largest is about two feet tall and holds in both hands a parasol that rises another foot above her (p. 30). Some figures in this group hold staves, and each of the faces is given distinct character. Each lady has a different hair style, and none looks particularly Chinese.

Other objects are even more unusual. One, described as: "a bronze ves-

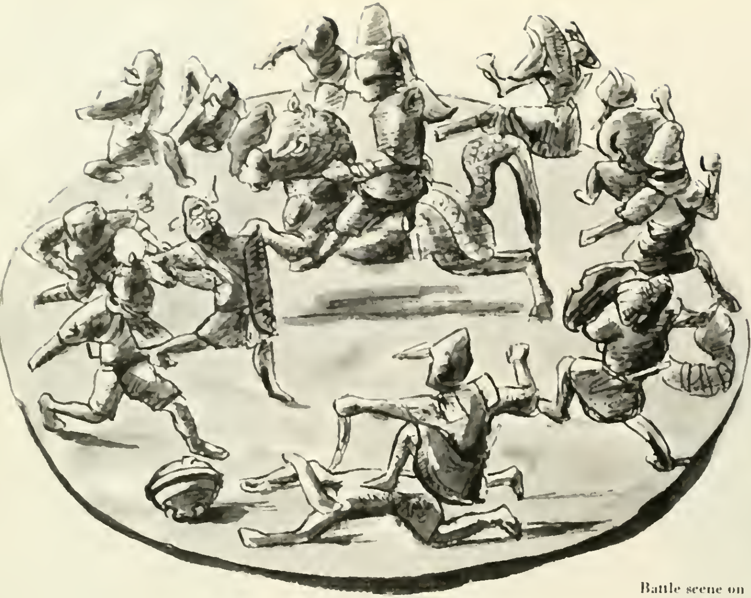
sel with a pinched waist, claw feet, and two handles in the form of tigers," is of Type II (*ca.* 176–168 B.C.). It was found half-filled with cowrie shells, which were used as money in ancient China. The lid of the vessel—about thirteen inches in diameter—forms a stage for a miniature human sacrifice, involving scores of human figures and animals (p. 39). The vessel is no more than eighteen inches high, and each of the human figures is about two inches tall. Even so, details of facial expression, clothing, and hairdo are rendered with surprising faithfulness to life. In addition to animals and humans there are two large drums of the Dông-so'n type, eighteen smaller drums, household utensils, and other paraphernalia. The sacrificial scene takes place in front of an open-sided shed with what appears to be a bamboo roof—an interesting detail in the light of controversial theories that have been advanced in the past about the origin of the "piecrust" Chinese roof.

SEVERAL other vessels filled—or nearly filled—with cowrie shells were fitted with covers of the same naturalistic, or anecdotal, style. At least one other shows a human sacrifice on an open plain. In another, two-inch figures depict a fight between cavalry and infantry, and may bear out statements in *The Histories of Han* about the people of Szechwan who, acting in a private capacity, crossed the Yunnan borders on slave-raiding expeditions. This bronze, shaped like a Dông-so'n double drum, is about twenty inches high, and has a cover about fourteen inches in diameter (p. 38). Again, the human figures are some two inches tall, and the details of their armor, weapons, and facial expressions are remarkably lifelike.

The same grave yielded a bronze vessel of similar type. It is about ten inches high and drum-shaped. In the center of the lid, which is about twelve inches across, is a sculptured landscape setting, similar to those on the Han "hill-jars," or censers. Around its outer edge is a row of seventeen human figures, a big-tailed sheep, a water buffalo, a bull, and a horse, all in exacting detail. The human figures, each only two inches high, show an amazing variety of costume and facial type. To judge by the packs on the backs of some figures, this may be a piece of genre art—a market scene, or something of that order. However, at



Breadth of artistic form in Shih-chai-shan material can be seen on these pages. Scabbard of sword, *far left,* has an abstract design that is almost Celtic. Tiger and insect on blade, *above,* are incised. Armed horseman and bulls on vessel, *center,* are examples of three-dimensional sculpture.



Battle scene on lid of a cowrie shell container may refer to slave-raiding expeditions in Yunnan by people from Szechwan Province.

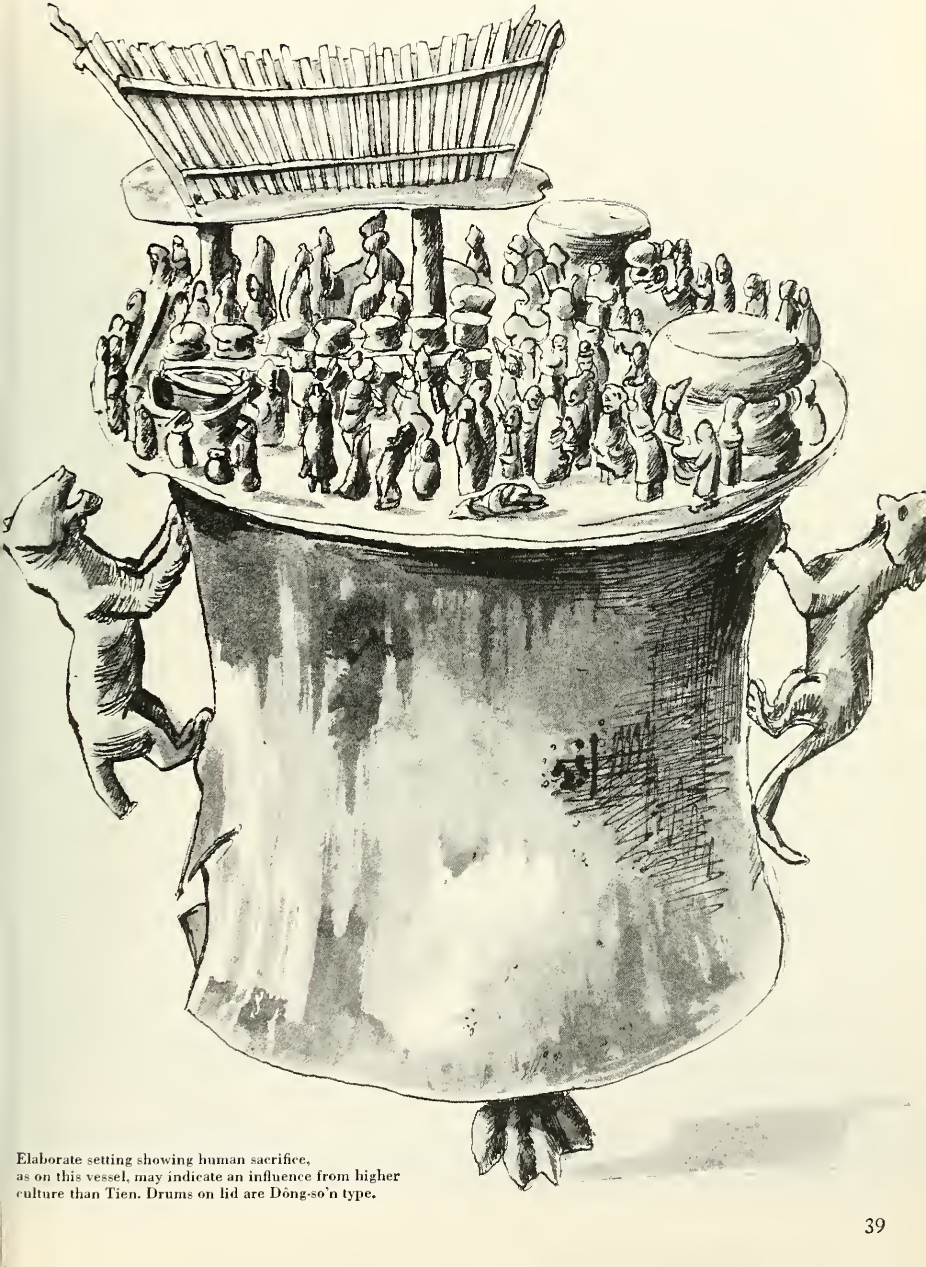
least one of the figures has a full, long beard—a characteristic of hairy northern peoples—and he and a companion are turned to face the audience, so the scene may have some ceremonial significance. This possibility is further enhanced by the fact that four bulls are cast in high relief around the base of the vessel. A recent Chinese periodical has suggested that these figures (shown on the cover) represent tribes and clans subject to the Tien.

Then there are the large bronze drums, some identical in shape and style of decoration with those of the Dông-so'n type site, while others are unique. One of these is a drum about three and a half feet in circumference. It shows a ceremonial procession in which three elderly people (one of whom seems to be a woman) are carried in boat-shaped open litters of a basket weave (pp. 30-31). Each litter is supported by four men at either end of T-shaped carrying poles. Following in a parade are men and women carrying baskets on their heads and accompanied by large dogs, while overhead a group of long-necked birds, probably cranes, fly in the opposite direction. This scene may be proof of historical statements that some southwest peoples carried their dead from tribe to tribe in litters before burial. Facial types, costumes, and everything else on the drum would be less surprising had the object been discovered in South America, for these details are unlike any ever seen in Chinese art. The shape of the drum itself, of course, and the abstract decoration around the lower border of the illustration are typical of Dông-so'n.

Weapons have always proved to be one of the best means of dating a newly discovered archeological site, and the armor and arms at Shih-chai-shan are no exception. Many, like the "dagger-ax," or *ko*, which appear frequently, are Chinese, and can be compared with other known examples of the same type. Furthermore, several examples have waved blades, and may prove that the origin of the kris, or typical serpentine-bladed Malay fighting knife, was the Chinese hafted weapon.

Of the swords, some are short like the Roman *gladius* or the Perso-Scythian *akinakes*, while others have long, straight, double-edged blades. Many swords have gold scabbards covered with striking abstract designs based on an almost Celtic type of spiral decoration (p. 36). Other weapons that have no Chinese prototypes include several broad-bladed daggers, nearly triangular in shape, the hilts of which represent snakes' heads or stylized human figures. Fighting picks resembling the *sagaris*, which were so typical of some Bronze and Iron Age finds in Siberia, are decorated in many cases with full-round animal sculpture, and, in at least one case, with a human figure. The blades of most of these weapons are covered with incised decorations. One shows a man fighting a tiger while a monkey bites the tiger's tail. Another shows an insect pursuing a tiger (p. 37). While these scenes may have had some ritual significance, it would seem that a strong sense of humor was the keynote in some representations.

Despite all that is not known about the finds from Shih-chai-shan, this appealing art reveals much about the ancient Tien. Their royal house came from the ruling families of the State of Ch'u in Hunan, but their art had affinities with other styles that spread throughout the Malay Archipelago and into southern mainland China. Another people, once lost to all but obscure sources, has been made to live again through the careful efforts of an archeological expedition.



Elaborate setting showing human sacrifice, as on this vessel, may indicate an influence from higher culture than Tien. Drums on lid are Dông-so'n type.

MT. WASHINGTON

Many species of arctic and boreal plants thrive on

FLORAS

wind-swept slopes

Flower-covered fell-field, *left,* is on one of the shoulders of Mt. Washington.

Aromatic, lavender mats of Lapland rosebay hug the rocky mountain slopes.

The White Mountains of New Hampshire, which are part of the larger Appalachian system, occupy most of the north-central portion of the state. One range—the Presidential—is located in the White Mountain National Forest, and from it towers 6,288-foot Mt. Washington, the state's highest peak.

While western mountains are, of course, considerably higher, various aspects of Mt. Washington make it particularly interesting to scientists.

The Laurentide Ice Sheet, which covered some five million square miles during the Pleistocene epoch, moved over the White Mountains and south into New York. Comparatively little is known about the thickness of that great glacier, but boulders have been found on the top of Mt. Washington that are not indigenous to the region, but are composed of a granite found only to the north. Various geologists have decided that the ice sheet passed over the top of the mountain, although so great a thickness has also been disputed. In addition, glacial striae have been found on Mt. Washington's summit and in adjacent areas, and these seem to show that the glacier was about a mile deep at that point.

Ecologists and botanists have devoted considerable time to the study of the flora of the region, which present some remarkable characteristics. For instance, timber line on Mt. Washington is at about 4,000 feet, while in the Rockies it is at about 10,000 feet. One reason for this arrest in the vegetation is the prevalence of extraordinarily high winds, frequently recorded in excess of 100 miles per hour.

Temperature on the mountain is low arctic; at sea level, equivalent temperatures are not found south of Labra-

White or pink-tinged alpine bilberry, *Vaccinium uliginosum* L., grows on the barren heights of Newfoundland south to northern New York and Minnesota.

Diapensia blooms in low tussocks in alpine areas of New York to the Arctic. Dense mats of this member of primrose family help to hold the rocky terrain.

A member of rose family, *Potentilla Robbinsiana* Oakes was named after J. W. Robbins, who discovered plant during the middle nineteen hundreds.

dor. Frequent and heavy frosts in both spring and fall, consistently cool summers, and the high winds all contribute to the existence of the alpine flora, which includes some unique species.

In the Presidential Range, the alpine region extends for a length of seven or eight miles along the crests, at heights varying from 4,000 to over 5,000 feet. Here frost feathers can be found both summer and winter, and here the black spruce, firs, and other coniferous trees that grow normally on the lower slopes have become distorted and stunted by the winds. Above this point there is a noticeable difference between the plants that grow in relatively protected and those in unprotected areas. The spots most subject to attack by the violent winds are, necessarily, dry and here grow dwarfed shrubs, sedges and some grasses, lichens, and various mosses. The more sheltered areas are wetter and, as a result, are able to support a more conglomerate community of heath plants and meadow flowers.

These two environments support both arctic and boreal species—some 65 of the former and about 125 of the latter. Again a comparison can be made to Labrador, for in the number and types of species there are great similarities between those of Mt. Washington and those of the cold land that lies about 800 miles to its north. However, the arctic plants are not confined to the fairly limited alpine zone, but occasionally are found below it.

On one shoulder of Mt. Washington is a typical, sheltered alpine fell-field, where the pictures on these pages were taken. It is above the timber line and strewn with rocks. Here is found the densely clustered *Diapensia lapponica* L., with its heathlike foliage, clinging to the rock terraces. Here also is *Potentilla Robbinsiana* Oakes, a cinquefoil that grows only on White Mountain heights, often on "striped ground." This is a geological phenomenon caused by frost action, during which various sizes and types of small rock fragments and pebbles are separated into alternating rows.

These and many other species in the rugged region are found during June and July when the winds abate and the alpine spring reaches its height.

Bell-shaped flowers are of *Cassiope hypnoides*, member of Ericaceae family.

Phylogenetic Riddle

Taxonomic studies indicate olive warbler perhaps was misclassified a century ago

By William G. George

The olive warbler *(Peucedramus taeniatus)* is an inhabitant of pine-fir forests on mountaintops from Nicaragua northward through Honluras, Guatemala. western Mexico, and southern Arizona. For over a cenury it has been classified in the Paruidae. the American songbird family known as the wood warblers. The allocation now appears questionable; the bird may prove to be not a wood warbler after all.

Until the latter part of the nineeenth century. the bird was included n the genus *Dendroica.* Members of his largest subgroup in the family are ermed true wood warblers, and inlude other pine-loving species such as the Audubon's and Grace's warblers. with which the olive warbler occurs in breeding season. For minor reasons it was moved from this genus.

Of the approximately 8,700 contemporary bird species, about 4,000 are Oscines, or songbirds. They comprise a suborder of the last avian order o arise in evolution—order Passeriormes, or the perching birds. which possess an elaborate vocal organ. Depite their comparatively recent origin. they have colonized every sizable and area on earth except Antarctica, nd have invaded and exploited nearly every terrestrial environment. Even many small islands far from the coninental masses now contain them, and hese endemic populations, such as the Galápagos finches and the Hawaiian honeycreepers, often pose very difficult systematic questions. Although they undoubtedly stemmed from mainland birds of the past, the evidence of that relationship was apparently erased when the original pioneering birds acquired new adaptations or when the mainland progenitors themselves either became much modified or became extinct.

The equivalents of oceanic islands also occur on the continents. An example of this. if the relationship of the olive warbler to the wood warblers can indeed be doubted. is the coniferous forests of mountaintops. where the olive warbler is confined. As already stated. *Peucedramus* looks like a wood warbler. But of greater significance perhaps. it is a "nine-primaried" bird. That is. its outermost flight feather. the tenth primary, is vestigial and so obscure that only nine flight feathers show in the wing. This is a relatively exceptional condition among the songbirds. but in North. Central. and South America there are about nine hundred nine-primaried species, most of which are considered to be offshoots of a common nine-primaried ancestor. Together, they are called the American nine-primaried Oscines, and include principally the wood warblers. honeycreepers, tanagers. blackbirds. and orioles. plus the sparrows. buntings, cardinal grosbeaks, and finches.

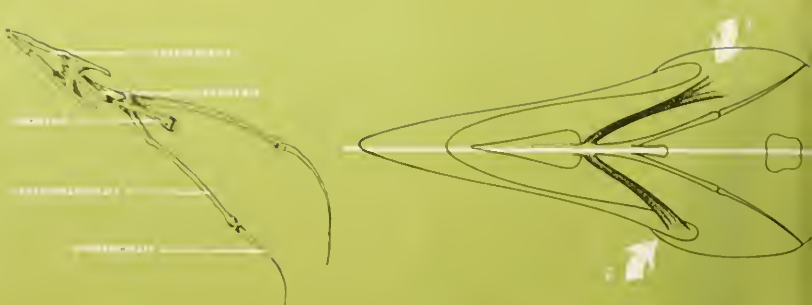
Ornithologists agree that the wood warblers, tanagers, and honeycreepers are very near kin. Besides being nine-primaried, they are mostly Neotropical (that is. they occur chiefly south of southern Mexico) and have intergrading bill and plumage features. Also, the plumages of the olive warbler fit rather well into the over-all plumage spectrum of the warbler-honeycreeper-tanager assemblage. Neither the gray-yellow-green tones of the female and the first-year male, nor the tawny coloration of the head and breast and the black face mask of the full adult male, introduces a novel element. Therefore, it was thought that the birds were correctly classified.

Classification is a complex procedure, in which anatomy, behavior, and biochemistry all play a part. It is study of these criteria that suggests that the olive warbler may not be a member of any other group in the American nine-primaried Oscines. First let us look at the bird's anatomy.

Bones: Associated with the tongue of birds are eight small interconnected bones that form a single Y-shaped structure called the hyoid apparatus. The forks of the Y embrace the underside of the skull; the other bones extend into the mouth between the lower jaws. The tongue is attached to the front pair of bones, the paraglossalia. Just behind these is an important bone called the basihyale. The basihyale is of interest because in shape it varies practically not at all among related songbirds. In wood warblers, honeycreepers, tanagers, blackbirds, orioles, and in all American nine-primaried finch-billed types, it takes the form of a knife blade. Only the olive warbler is the exception; its basihyale is shaped like an ice pick.

Muscles: The hyoid apparatus is strung with muscles that move the ap-

Rarely photographed olive warbler eeds young in nest lined with fibrous mattress" stripped from living leaves.



Hyoid of the typical wood warbler is at left. In olive warbler and kinglets, stylohyoideus muscle is attached to

paratus and thus the tongue. One such muscle is the stylohyoideus, attached to the basihyale. From the basihyale it extends back to the posterior tip of the lower jaw in all the American nine-primaried Oscines except one honeycreeper (the banana quit), and the olive warbler. It extends to the side of the skull (squamosal bone) in the former bird and to the base of the skull (basitemporal plate) in the latter.

The jaw muscles of the songbirds vary in the arrangement of their constituent fibers; different jaw muscle patterns result from this variation, and related birds share a particular pattern. The olive warbler's pattern differs greatly from those of all the studied wood warblers, honeycreepers, tanagers, and allied species.

BEHAVIORALLY, too, some significant variations are apparent. The female olive warbler builds the nest with no assistance from the male. Like most songbirds she constructs a cup nest; ordinarily she selects a crotch among the terminal needles of a branch in a pine or a fir as a nest site. She then gathers rootlets from the forest floor and spider webs from the trees and combines them to form a scanty nest framework. Next, she strips off, with her bill, white fibrous material from the underside of the living leaves of the silver-leafed oak; this she uses to line the nest's inner wall, in effect placing a thick mattress atop springs of rootlets. Finally she decorates the outside of the framework with dozens of brownish bracts from the needles of the yellow pine. No other known songbird uses pine bracts and the living fibers of the silver-leafed oak in the construction of its nest.

So far as is known, the wood warblers and their near allies maintain spotlessly clean nests and nest sites throughout the period of raising young. Olive warblers do not. The outsides of their nests are found to be soiled with excrement after the young have departed. The soiling apparently occurs during the final day or two that the young spend in and about the nest.

In addition, the call note of the olive warbler is a silvery descending whistle, somewhat reminiscent of the "phew" call of the western bluebird, and seemingly none of the wood warblers has a similar call note.

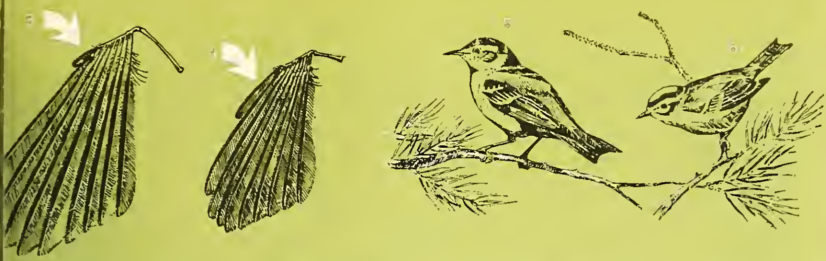
Biochemical indications of the difference between the olive warbler and the other species can be found in a comparison of their egg white proteins. Proteins are large molecules composed of chains of amino acids. It is known that the amino acids become arranged into chains at the direction of the genes; the protein structures of animals thus are inherited characteristics. Particular proteins characterize every species of animal, and closely related animals have similar protein "patterns." Study shows that egg white proteins of the olive warbler are unlike those of other species in the assemblage.

As the above demonstrates, the olive warbler differs on many points from its supposed nearest relatives and allies, and therein lies the riddle. Is it a primitive wood warbler that has retained the primitive anatomical, behavioral, and biochemical features of its ancestors—features that seem to us, from our narrow vantage point at the edge of the evolutionary past, aberrant? Or is it in fact a modern wood warbler that has diverged from its contemporary relatives in some ways but not in others? It may, of course, be another kind of bird altogether, one that has been mistaken for a wood warbler because of the nature of its distribution, its ecology, and its external morphological characteristics.

Unfortunately, it is impossible to determine beyond doubt which of these hypotheses is correct. Few traces of the primitive songbirds appear in the fossil record, and contemporary songbirds lack the gradation of trenchant anatomical or other "conservative" variations that would enable ornithologists to plot the course of their ev[illegible] tion. (The reason that variations [illegible] jaw muscles and hyoidean structur[illegible] may not be "conservative" is discu[illegible] later.) Thus it is difficult to know which characteristics of the living forms are "primitive" and which are "recent." We know scarcely more about the primitive songbirds than that they underwent adaptive radiation throughout the world, evolving eventually into the present types.

Yet, one important aspect of the matter is clear enough: birds of only distant relationship but of very similar attributes emerged from the evolutionary process. In most parts of the world, for example, small, thin-billed, insectivorous birds, which we call warblers, arose. The New World produced warblers with only nine visible primaries, the Old World produced warblers with ten. Until recently, warblers did not seem to be otherwise well differentiated. Now it is known that they differ in jaw muscles, hyoidean features, and egg white proteins. The olive warbler, though it is a nine-primaried bird and displays certain plumage marks typical of wood warblers, has the hyoidean distinctions and jaw musculature of the Old World warblers, and its egg white protein "formula," too, seems close to those of certain Old World species.

Ornithologists have emphasized the taxonomic importance of the relative



ase of skull (1); in wood warblers it fastens to tip of the wer jaw (2). Olive warbler's tenth primary (3) is much shorter than kinglets' (4), but its plumage (5) is very like that of Madeira Island kinglet, the firecrest (6).

ength of the tenth primary in their fforts to divide songbirds into natural amilies. The tenth primary, unlike he bill, tongue, plumage colors, plumge patterns, and leg scales, varies ittle within and between closely reated groups, and because it is an exernal structure it can be readily xamined in study skins. Studies of ternal structures, on the other hand, relatively difficult and time-coning and require the use of specially pared specimens. These usually are vailable except at larger museums. the attention accorded to the tenth rimary reflects this situation, in part.

Like any structure, the tenth prinary is subject to change through atural selection, and a change in its ength certainly may take place toward he direction demanded by flight needs. The birds of nearest relationship to the songbirds—that is, the primitive perching birds, such as the tyrant flycatchers—generally have a long tenth primary, while most songbirds show a tendency to develop a short tenth. This has led to the conclusion that the nine-primaried condition represents a late evolutionary step toward specialization and that the nine-primaried species are the most "advanced" songbirds. However that may be, independent lines of the advanced species have arisen in songbird evolution. Larks, swallows, pipits, starlings—and other groups as well—none closely related to any of the American nine-primaried Oscines or to each other, contain nine-primaried species. Moreover, several songbird genera contain both nine- and ten-primaried birds, a fair indication that the length of the outer flight feather is not always a reliable clue even to a bird's generic affinity, hence is not necessarily diagnostic of family relationship.

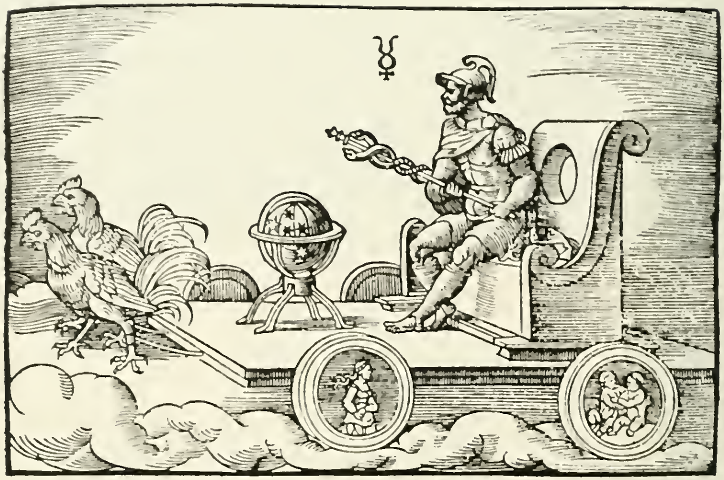
It is true, on the other hand, that the non-Parulid characteristics of the olive warbler may qualify no better than the reduced tenth primary as reliable evidence of family relationship. Consider the hyoidean structures and jaw muscles. They constitute an important part of a bird's feeding equipment. As a rule, the feeding structures (the bill and the tongue, for example) are highly adaptive, and birds with similar dietary habits tend to have similar dietary equipment, regardless of their ancestry. The fact that the hyoidean structures and jaw muscles of the olive warbler are unlike those of the wood warblers could be a mere reflection of differences in the feeding habits of the species, although no such differences have yet been noted. Like the wood warblers, the olive warbler is insectivorous, and in its foraging behavior it often has been compared to the pine warbler. Why, then, does it possess dietary structures that deviate radically from those of its supposed near relatives?

A wide variety of feeding types and a corresponding diversity in bill and tongue shapes occur in the wood warbler-honeycreeper-tanager assemblage. Most of the species take insects at least part of the time, some feed largely on fruits, others on seeds, and still others on nectar. Yet, in spite of this dietary divergence, their hyoidean structures and jaw muscles are essentially similar. Accordingly, it is difficult to explain away the exceptional morphology of the hyoidean structures and jaw muscles in the olive warbler. It may be, however, that the bird has evolved unorthodox or specialized feeding traits that do not appear in the gross maneuvers of food-getting, but instead find expression in the delicate refinements of the internal dietary structures.

Little can be stated at present about egg white proteins and behavioral traits as sources of dependable, higher level taxonomic evidence, as both studies are in their infancy. In any case, nest construction, nest sanitation, call note, and egg white proteins of the olive warbler are atypical of the Parulidae and their allies, which lends weight to the possibility that the bird is indeed misclassified.

One question, of course, follows: What kind of bird may the olive warbler be, if it is not a wood warbler or a wood warbler relative? No entirely satisfactory answer has yet been proposed. Over-all, the species has more characteristics in common with the kinglets (genus *Regulus*) than with other American birds. The kinglets, of which there are two species in America and two in the Old World, presently are classified in the family of Old World warblers, for they have ten visible primaries. But their tenth primary is short. Their hyoidean features and jaw muscles are almost identical with those of the olive warbler. Additionally, the kinglets share with the olive warbler obvious distinctions in respect to nest construction, plumage, and bill shape. One kinglet, that of Madeira Island off the west coast of North Africa, is markedly close to the olive warbler in bill shape and in plumage. Another kinglet, the golden-crowned of America, occupies the same fir forests of southern Arizona, central Mexico, and Guatemala as does the olive warbler.

Quite possibly the olive warbler is a nine-primaried kinglet; at the very least, it is a bird that presents a typical example of the phylogenetic riddles that are presented by the songbirds.



MERCURY is shown in sixteenth-century woodcut.

SKY REPORTER

Medieval astronomers erred in describing Mercury and Venus

By SIMONE DARO GOSSNER

IN PTOLEMAIC ASTRONOMY, the solar system was believed to consist of seven planets traveling around the earth. In order of their increasing distance from earth, the planets were: the moon, Mercury, Venus, the sun, Mars, Jupiter, and Saturn. According to this scheme, Mercury and Venus were called *inferior planets* because their distances from us were thought to remain always shorter than the sun's. Mars, Jupiter, and Saturn were called *superior planets* for the opposite reason. These terms are still used occasionally, although the acceptance of the Copernican system has rendered them meaningless. We know now that planets travel around the sun, instead of around the earth; Mercury and Venus are alternately closer to or farther from us than is the sun; and, at its close approaches, Mars can come within less than half the sun's distance from earth.

Only the telescope assisted by photography and spectroscopy could reveal the physical nature of planets. Before these methods were developed, planets were described in fanciful terms, mostly parroted from Aristotle. A textbook published in 1582 said of Venus that "it is humid and moderately warm," and of Mercury that "it remains close to Venus and imitates its nature." The dearth of scientific information was often compensated by exhaustive discussions of the planets' astrological influences. Illustrations also reflected this trend; like those reproduced on these pages, they combined mythological attributes with zodiacal signs traditionally associated with each planet (Virgo and Gemini for Mercury, Taurus and Libra for Venus).

In the light of modern studies, it is very plain that medieval astronomers could not have erred more in believing that Mercury and Venus are similar in nature. They both are terrestrial planets—that is, they are solid and of moderate size, but the similarity ends there.

Excluding asteroids, Mercury is the smallest planet. In fact, with its 2,900-mile diameter, it is even smaller than the largest satellites of Jupiter and Saturn. It travels around the sun at an average distance of 36 million miles, completing one orbit in 88 days. By observing its surface markings, it has been found that Mercury always keeps the same face turned toward the sun. It is probable that this peculiarity makes it at once the hottest and the coldest place in the solar system. The sunlit side has a temperature in excess of 600 F., whereas the hemisphere that remains in perpetual darkness may be close to the absolute zero of the temperature scale (−459 F.).

One consequence of such extremes of heat and cold is that Mercury is probably devoid of an atmosphere. If it ever had one, its gases would have been driven away by the intense heat on one side and frozen to the planet's surface on the other. It was suggested recently that Mercury might have retained a tenuous atmosphere of the heavy gas argon. Unfortunately, observational data to confirm or disrove this theory cannot be obtained by conventional means, ecause argon does not emit spectral lines in the visible ange. Its lines occur in the far ultraviolet and are blocked ff by the earth's atmosphere. They could, however, be bserved from an artificial satellite, and one may hope that uitable experiments will be performed eventually.

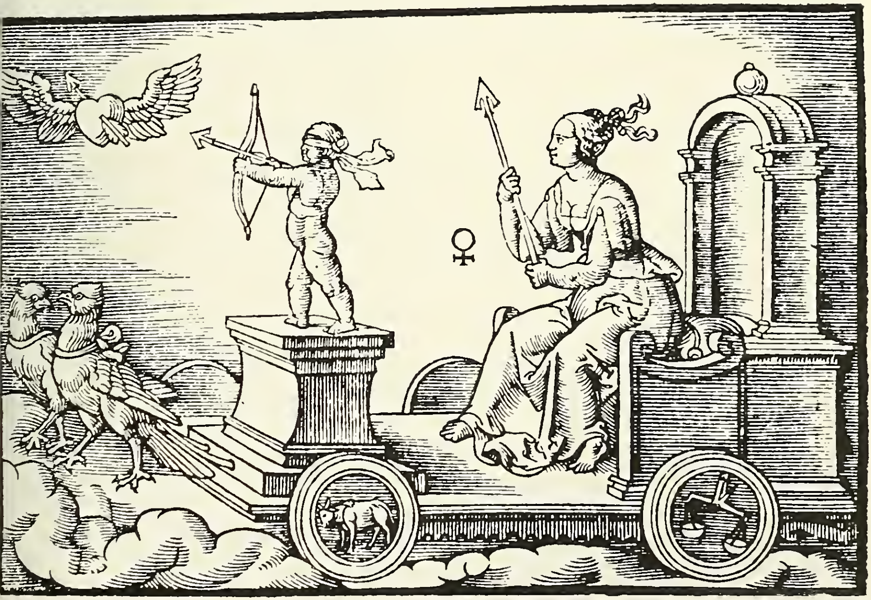
Although we are as yet unable to sample Mercury's surace, the manner in which it reflects light suggests that it s similar to the surface of the moon in appearance and omposition. This would imply a rocky, arid land, possibly overed by a layer of dust. According to recent investigaions, however, the average density of Mercury is higher han that of the moon. It would seem, therefore, that the imilarity between the two is only skin-deep.

AT periodic intervals, Venus comes closer to the earth than any other major planet. In spite of such advanageous proximity, it remains almost as much of an enigma oday as it was three centuries ago. Its rotation period, the ature and appearance of its crust, and even its surface emperature are unknown or highly uncertain, because the lanet is cloaked in a deep and very dense atmosphere.

The rotation period of a planet—that is, the length of ts day—is usually measured by timing the successive reppearances of one of its surface features. Such attempts ave failed in the case of Venus, because its visible markngs usually turn out to be clouds in its atmosphere. These louds wander about and eventually dissipate, thus foiling ttempts to time their reappearance. Estimates of Venus' otation period that have been derived from other methods range anywhere from two weeks to 225 days—the length of its revolution around the sun. There is accumulating evidence in favor of the 225-day value.

As to Venus' temperature, it is difficult to measure because conventional methods yield values corresponding to its visible surface, which is, in fact, the top layer of its atmosphere. It had long been thought that Venus might have an ideally balmy climate, thanks to the thickness of its atmosphere, which might shield it from strong sun rays. Such wishful speculations came to naught a few years ago when observations with radio telescopes (which penetrate atmospheric layers) revealed crust temperatures in excess of 600°F. These findings were so unexpected that they were treated at first with considerable reserve even by the astronomers who had obtained them. But they were confirmed by later experiments. The only remaining doubt concerns the various depths at which these temperatures are reached. It could possibly be an intermediate atmospheric layer rather than Venus' actual solid surface. As this is being written, a United States interplanetary probe is speeding toward Venus, and it is hoped that its instrument package will yield valuable information on problems such as these.

Even with moderate temperatures, Venus would be far from an idyllic abode for life as we know it. Spectroscopic observations have failed to reveal the presence of oxygen in its atmosphere, which seems to consist mainly of carbon dioxide. Although Venus is a near twin of the earth in size and density, and it lies within the region of the solar system where life could be sustained, it does not appear to be the promised land of possible human migrations of the future.



Mythological influence is seen in depiction of planet Venus.

THE SKY IN FEBRUARY

From the Almanac:

First Quarter	February 1, 3:50 A.M., EST
Full Moon	February 8, 9:52 A.M., EST
Last Quarter	February 16, 12:39 P.M., EST
New Moon	February 23, 9:06 P.M., EST

For the visual observer:

Mercury, at its greatest western elongation on February 13, will be most suitably placed for observation during the first half of the month (+0.2 magnitude at midmonth). The planet will be visible low above the southeastern horizon before sunrise. It will rise about seventy-five minutes before the sun on February 1 and 15, and one hour before on February 28. Mercury will be about one degree south of Saturn in the morning of February 28.

Venus, in the morning sky (—3.8 magnitude), will rise approximately three hours before the sun on February 1 and 15, two and one-half hours before on February 28, and will be in the southeastern sky at sunrise.

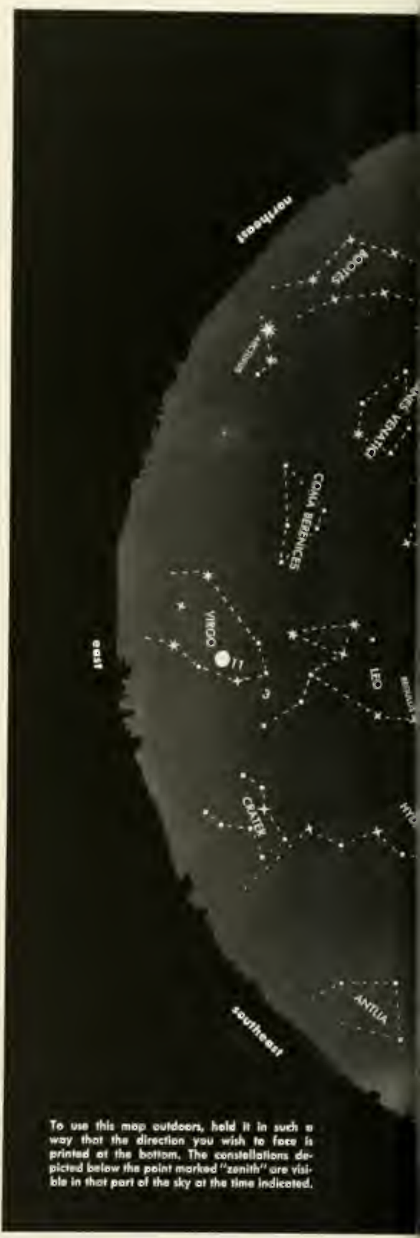
Mars, between Leo and Cancer (—0.9 magnitude), will be at its shortest distance from earth—just over 62 million miles—at 10:00 P.M., EST, on February 2. These near approaches of the planet occur once every twenty-six months, but the shortest distance attained varies greatly from one lap to another, the minimum possible being about 35 million miles. On February 2, Mars will rise at sunset, will pass nearly overhead at midnight, and will still be in the northwestern sky at dawn. Its ruddy color should help identify it. Mars will be visible all night throughout February, except for an hour before sunrise during the last week.

Jupiter, in Aquarius (—1.6 magnitude), will be low in the western sky at dusk. It will set three hours after the sun February 1, and two hours after on February 15. By the end of the month it will be too close to the sun to observe.

Saturn, in Capricornus (+0.9 magnitude), will be in conjunction with the sun and lost in its glare on February 3. Accordingly, the planet will be unfavorably placed for observation during February. In the last few days of the month it might be seen low in the southeastern sky just before sunrise, but even on February 28 it will rise only about an hour before the sun. On that date it will appear very close to Mercury (see above). The two planets may be distinguished if one bears in mind that Saturn will be fainter than Mercury at that time.

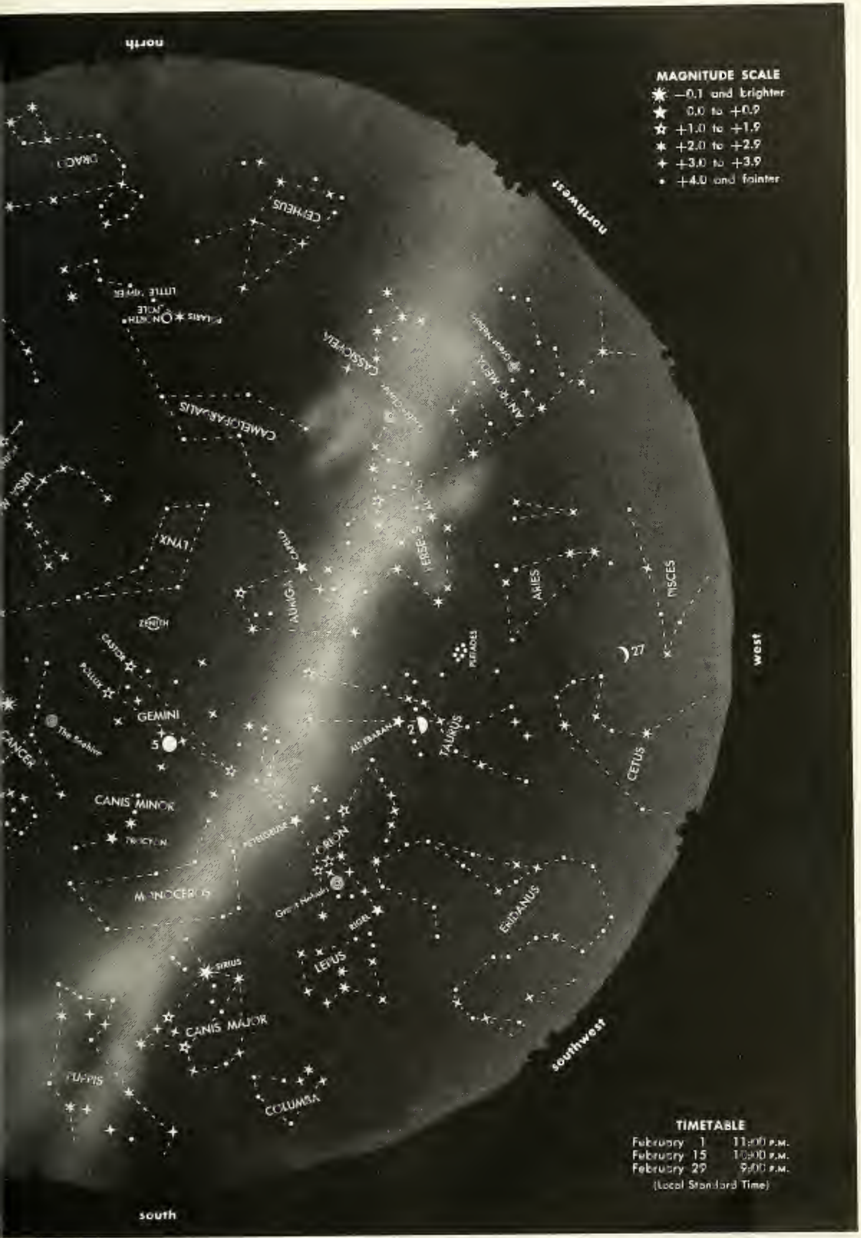
DOUBLE AND MULTIPLE STARS

A surprisingly large proportion of all stars seem to be double or multiple systems. Within a radius of fifteen light-years from the sun, astronomers count seventeen single stars, ten doubles, and two triple systems. Irregularities in the motions of some of these nearby stars suggest the presence of at least two more invisible companions, which could be massive planets. Among the thirty brightest "stars" in the sky, fifteen are observed to be single, nine double, two triple, three quadruple (Capella, Alpha Crucis, and Regulus), and one sextuple (Castor), for an actual total of fifty-seven stars. Of this total, more than two-thirds are members of double or multiple systems. There is little doubt that this ratio will become higher when improved equipment allows a search for even fainter companions.



To use this map outdoors, hold it in such a way that the direction you wish to face is printed at the bottom. The constellations depicted below the point marked "zenith" are visible in that part of the sky at the time indicated.

On these pages MRS. GOSSNER presents the second in her 1963 series—a co-ordinated review of the solar system.


north
MAGNITUDE SCALE
−0.1 and brighter
0.0 to +0.9
+1.0 to +1.9
+2.0 to +2.9
+3.0 to +3.9
+4.0 and fainter
northwest
DRACO
CEPHEUS
LITTLE DIPPER
POLARIS
NORTH CIRCLE
CASSIOPEIA
Great Nebula
ANDROMEDA
Double Cluster
CAMELOPARDALIS
URSA M
LYNX
PERSEUS
CAPELLA
AURIGA
ARIES
PISCES
ZENITH
PLEIADES
27
west
CASTOR
POLLUX
GEMINI
The Beehive
CANCER
5
2
ALDEBARAN
TAURUS
CETUS
CANIS MINOR
PROCYON
BETELGEUSE
ORION
MONOCEROS
Great Nebula
RIGEL
ERIDANUS
LEPUS
SIRIUS
CANIS MAJOR
PUPPIS
COLUMBA
southwest
south

TIMETABLE

February 1 11:00 P.M.
February 15 10:00 P.M.
February 29 9:00 P.M.
(Local Standard Time)

Sliced lengthwise and cut at 55 cm. intervals, the deep-sea core at the left shows pronounced changes in nature of sediment. Research ship *Vema* is above.

Time's Traces in Sediment

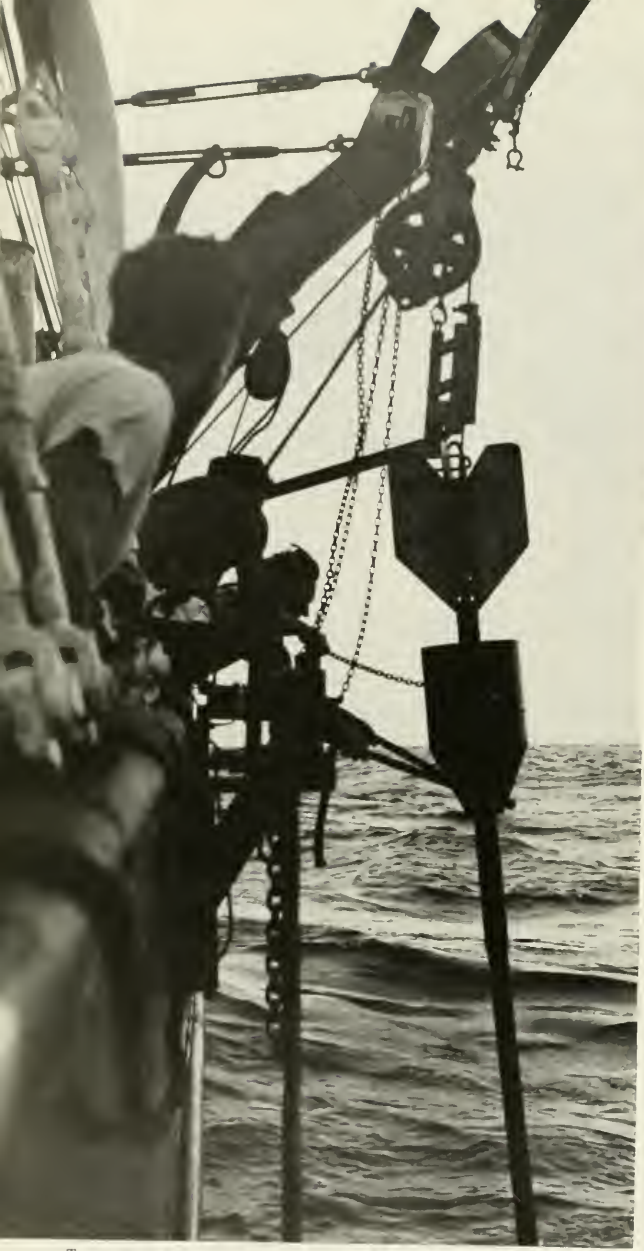
Ocean bottom is probed for knowledge

By David B. Ericson and Goesta Wollin

Since 1872, when H.M.S. *Challenger* set out on the world's first oceanographic expedition, many samples of sediment have been raised from the floors of the oceans, particularly from the bottom of the North Atlantic.

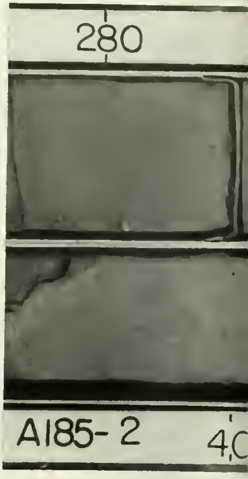
Between 1925 and 1927 the German research ship *Meteor* took a series of short cores about a meter long in the equatorial Atlantic. The coring apparatus was of the simplest kind; a tube with a lead weight to drive it into the sediment. W. Schott, the investigator of these cores, found that most of them included two layers, an upper one roughly twenty-four centimeters thick containing shells, or tests, of foraminifera now living in the equatorial Atlantic, and a lower one with tests of species now living in middle and high latitudes. Schott surmised that the lower layer had been deposited during the last Ice Age. This meant that about twenty-four centimeters of sediment had accumulated in this part of the Atlantic since the climatic change that caused the continental ice sheets to recede.

A new era in marine geology was initiated about fifteen years ago when the Kullenberg piston corer was first used to take samplings of deep-sea sediments. Essentially, the apparatus consists of a steel pipe with a mass of lead at the upper end and a sharp cutting edge at the lower end. Inside the pipe there is a freely moving piston to which the lowering wire is attached. When lowered from the ship, the apparatus hangs from a releasing device attached to a point some distance up on the lowering wire, so that there is a slack loop of wire between it and the piston at the bottom of the pipe. The



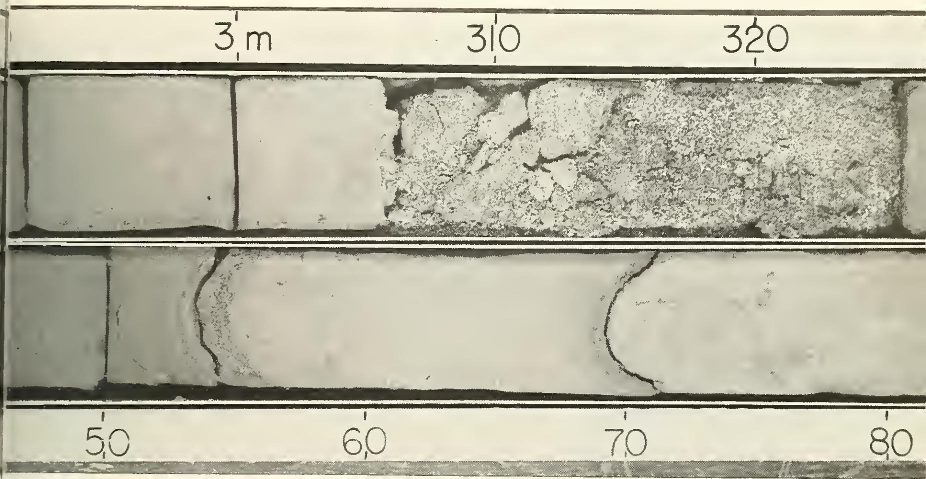
THOUSAND-POUND coring apparatus is retrieved with tackle aboard the *Vema*.

Visible at right are the coring tube, heavy lead weight, and the guide fins.



releasing device is actuated by a se
rate wire and weight that hang ab
five meters below the lower end of
pipe. When this weight touches the
floor, the releasing device is tripp
and the apparatus drops freely u
the cutting edge reaches the sedim
surface, by which time the loop
slack wire has become taut. From t
point on, the piston is held station
by the taut lowering wire as the p
is forced into the sediment by the
netic energy of the mass of lead at
top of the pipe. The piston puts hyd
static pressure to work to force se
ment into the tube, overcoming
friction between the sediment and
inner wall of the tube. Experience w
coring tubes without pistons sho
that rapid buildup of friction preve
the entrance of sediment after the c
ing tube has penetrated into it
about three meters. With the pist
device, cores twenty-five meters lo
have been taken. Presumably, long
cores could be taken if it were feasil
to handle coring tubes with heavi
lead weights on shipboard.

The piston coring tube was first us
by scientists on the Swedish ocea
ographic ship *Albatross* during
cruise around the world in 1947. Sin
then it has been adopted by all ocea
ographic institutions that take
active part in the study of deep-s
sediments. Research vessels of the L
mont Geological Observatory of C
lumbia University have collected abo

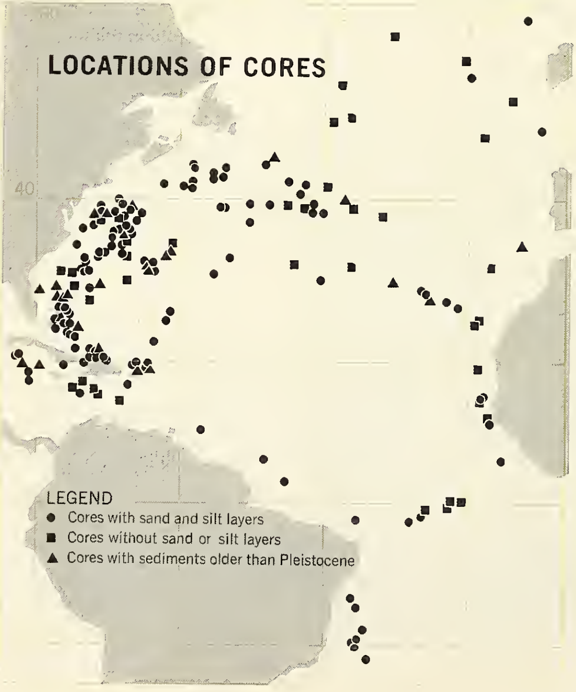


Sections of one core show layers of sediment that look similar except for calcareous sand at top, right. Chemical or microscopic study is necessary to interpret sedimentation processes in samples that appear to be homogeneous.

00 long cores—the largest collection
the Western world—during thirty
peditions under the leadership of Dr.
urice Ewing, Director at Lamont.

NE reason for such extensive cor-
ing has been to discover a com-
te climatic history of the Pleisto-
ne—the geologic period of the ice
es—as recorded by shifts in popu-
ions of planktonic foraminifera.
ese single-celled animals build tests
calcium carbonate, which they dis-
rd when they reproduce. It would
m that such a record could be found
any single core from some point
ll out in the Atlantic, but the study
thousands of cores has shown that
problem is not nearly so simple.
cording to the older conception of
ep-sea sedimentation, once the dis-
ded shell of a planktonic foramini-
had come to rest on the ocean floor,
emained there during geologic time
til, through drastic reorganization
the earth's crust, that part of the sea
or might be uplifted and subjected
subaerial erosion. No submarine
ocess was known that could inter-
e with the accumulation of fine min-
l particles and the hard parts of
nktonic organisms as they slowly
ned down.

From study of the many cores in
Lamont collection we have learned
t almost catastrophic redistribu-
n of sediment over large areas of
an floor may take place fairly fre-


LOCATIONS OF CORES
40
LEGEND
● Cores with sand and silt layers
■ Cores without sand or silt layers
▲ Cores with sediments older than Pleistocene

"Bottom" end of coring pipe is full of sediment after retrieval of device.

Pulling pipe back over rod extrudes core onto wrapper on deck of the *Vema*.

quently because of turbidity currents. Probably these submarine torrents are generated in several ways. One almost certain cause is the slumping of masses of sediment that have accumulated on slopes. Presumably, as the mass of sediment moves rapidly down the slopes it becomes a completely fluid mixture of sediment and water that travels at a high velocity and may cover great distances. The effect upon the sedimentary record in its path is disastrous. At one place the mass may remove sediment just as a stream on land erodes its bed; where the slope decreases, it may deposit quantities of sediment in only a few hours.

To avoid these disturbing effects we turned our attention to cores taken on isolated rises that could not be reached by turbidity currents, but here we encountered another source of confusion. We compared the vertical sequences of changes in various species of foraminifera in different cores, and found they did not match, even when the cores were from points only a few tens of miles apart.

Apparently, sections of sediment had been lost by slumping, no doubt triggered by occasional earth tremors. However, each core of Pleistocene sediment was vertically uniform in color and consistency, so we were unable to distinguish cores from which sections had been removed by slumping from other cores that may have included complete sections. In the meantime, we continued studying the fossil foraminifera in the many new cores brought back to the laboratory. We eventually found cores from different parts of the Atlantic Ocean where there were zones containing the same kinds of foraminifera. The zones were distinguishable from others containing different foraminifera. That the foraminiferal zones can be traced from the equatorial Atlantic into the Caribbean Sea and the Gulf of Mexico and northward to the Azores is proof, we believe, that the sediment sections are complete. Correlation of these zones was confirmed by a coiling ratio method described later.

It is mainly through the study of foraminifera in deep-sea sediment that we will be able to decipher the complete record of Pleistocene stratigraphy and climatic history. Over the years, a wealth of information on all
aspects of foraminifera has accu
lated, and most of it is readily av
able. For example, all older desc
tions of genera and species have b
brought together in an enorm
catalogue by Dr. Brooks F. El
Chairman and Curator of the Depa
ment of Micropaleontology at T
American Museum, and Angelina
Messina, Associate Curator. Since
catalogue's first publication by
Museum in 1940, it has expanded u
now it comprises sixty-nine volum
and it is constantly growing.

In view of the facile adaptability
the foraminifera and their long hist
of evolution, which began in the Ca
brian some 600 million years ago,
is not surprising that a really en
mous number of species are kno
and that many more are added ea
year by the hundreds of investigat
in all parts of the world who study t
remarkably useful group of organis
Their usefulness depends upon a co
plex of attributes, among which is t
ability to evolve rapidly. Thus, sin
species or even assemblages often r
resent relatively short spans of g
logic time. In addition, the anima
sensitivity to the local environm
and their small size make them re
tively easy to study. A thimbleful

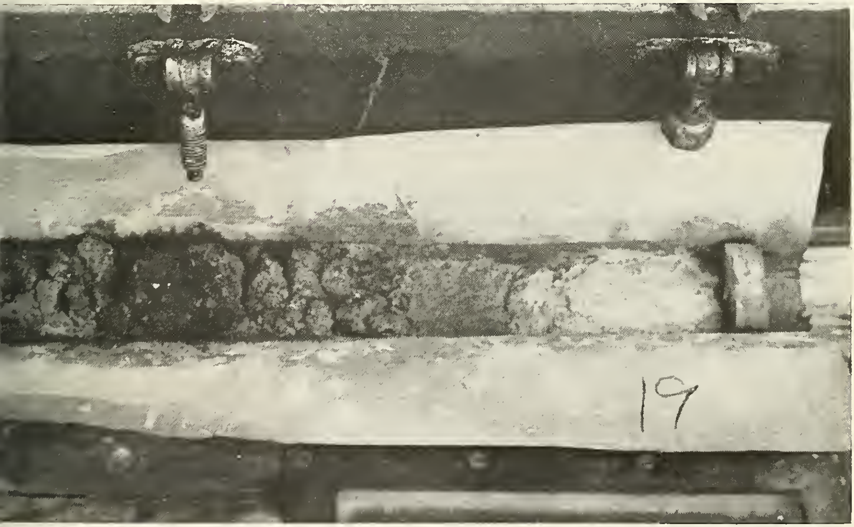
iment often contains thousands of
s, thus permitting the application
statistical methods to the analysis
small samples of assemblages found
il wells or on the ocean floor. Most
cies can be easily recognized with
w-power binocular microscope.

lmost all species of foraminifera
marine, and most live on the ocean
r. About twenty-five species, how-
r, are planktonic: that is, they float,
ried by general oceanic circula-
ns, at a shallow depth beneath the
face within reach of light, where
y feed on diatoms and other photo-
thesizing organisms. The plank-
ic foraminifera—particularly those
t are sensitive to temperature and
ose geographical distributions are
ited to the warm waters of middle
tudes or to the cold waters of high
tudes—are important to the investi-
or of past climates.

n the geologic past, slow accumu-
on of the calcareous shells of plank-
ic foraminifera on the sea floor has
ulted in thick deposits of chalk.
day, large areas of the bottoms of
world's oceans are receiving a slow
constant rain of discarded tests of
nktonic foraminifera. In such areas
tests of foraminifera make up from
to 50 per cent of the sediment.

In Lamont laboratory, the deep-sea core is split lengthwise and prepared for sampling and study. Core is also photographed to obtain lasting record.

In deciphering the deep-sea record of climatic changes by studying foraminifera, we follow the principle that the present is the key to an understanding of the past. The first question, then, concerns the present: how are the common planktonic species distributed in today's oceans? Thanks to the collection of living specimens from plankton nets that have been towed in various parts of the oceans and, particularly, thanks to the many widely scattered samples of the uppermost layer of sediment, we have a good general picture of the distribution of these species in the North Atlantic, and a somewhat less exact picture for the other oceans. We know from these distribution data that no species is completely cosmopolitan, and that some are rather



ldest sediment sample ever taken rests on its wrapper
oard the *Vema*. Oldest part of the core, dating back 100 million years, is at the left. Light-colored sediment at the right, near the core's top, built up in the last 10,000 years.

STAR-SHAPED discoasters, *above,* have been extinct about one million years. They occur in cores below level that marks Pliocene-Pleistocene boundary.

OLDER DISCOASTERS come from a lower level of core that yielded ones at top. Discovery of discoaster evolution in Pliocene was a key in finding boundary.

FORAMINIFERA in samples of deep-sea sediment provide oceanographers with indications of the chronology and the climatic history of Pleistocene epoch.

severely limited in their regional
tribution. In general, the bound
of geographical ranges of the sp
trend east and west, suggesting
temperature, as one of the ecolo
conditions, is the most important
tor limiting their ranges.

THE shells of most planktonic
raminifera are superficially
ilar to snail shells; they coil to
right or to the left. In some spe
almost all individuals coil in the s
direction. In others, dominance
right or left coiling varies with
region. Thus, in the Sargasso Sea
ing of the species *Globorotalia tr
catulinoides* is dominantly to the
The same species in the Caribbean
ally coils to the right.

The coiling ratio method we devi
can be put to effective use in corre
ing foraminiferal zones and measu
relative rates of accumulation. The
cumulation rate, in turn, permits
cise correlations from core to c
through which processes of deposit
can be studied.

Going back in time by determin
coiling ratios in fossil samples ta
every ten centimeters in cores, we
that the pattern of distribut
changed rather suddenly from tim
time during the late Pleistocene. F
the curves of *Globorotalia trunc
linoides*, it is evident that left-coil
dominance was exceptional during
late Pleistocene. Carbon-14 dating
also shown that a central province
left coiling has come into existe
during the last 10,000 years.

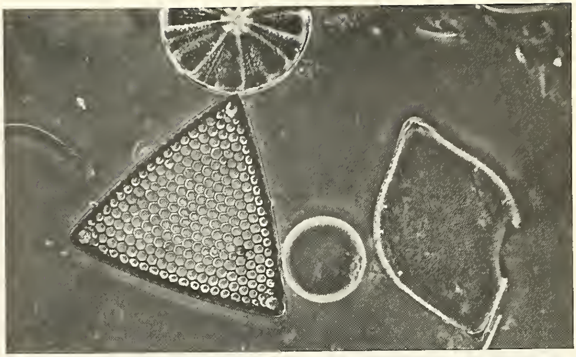
We have found additional evide
for change in oceanic circulation d
ing the late Pleistocene in cores fr
the flanks of a seamount. Fine clay a
lime particles that are swept from
top of a seamount by deep curr
scour come to rest on the lee flank—
side away from the direction of
current's flow. Alternations of coa
and fine layers in a core from
northeastern flank of the Muir S
mount, in the western North Atlant
show that the deep current now swe
ing the upper part of the mount m
have changed its direction from ti
to time during the late Pleistoce
and that the changes were synch
nized with climatic changes that
companied the advances and retre
of continental glaciers. We believe th
additional evidence of this kind
changes in oceanic circulation may
timately resolve the problems of p

ly how the ice ages were caused. n the study of pre-Pleistocene sedi- ts, discoasters — organisms that e been extinct for perhaps a million rs—are very useful guide fossils. cannot be sure whether the dis- sters were plants or animals, or ther they belonged to the Protista at catchall group into which it is venient to put those organisms that sess the attributes of both plants animals. We are fairly sure, how- , that they were planktonic in it, or drifted at or near the ocean ace. In older sediments from fairly stations in the North Atlantic occur in enormous numbers. It ns that no animals living on the om could have proliferated on a scale, because they could not sibly have found enough nourish- nt there. But for planktonic organ- s living at or near the surface, ndant nourishment could be pro- ed by photosynthesis. Furthermore, various forms, or "species," of oasters are of world-wide distri- ion, a characteristic of planktonic anisms, and one that enhances their ne as stratigraphic markers. Their ence from Pleistocene sediments ws that they were unable to cope h changing environment and be- ne extinct. Their distribution with ect to latitude hints that they were sitive to temperature. Recently we nd that the discoasters are reliable icators of the important transition ween the Pliocene and the Pleisto- e, because of a gradational extinc- n of species within the upper ocene period. Thus the discoasters ped to identify reliably, and for first time, the base of the Pleisto- e period. The rapid though grada- nal change in foraminiferal zones d, in particular, the extinction of discoasters indicate a correspond- ly rapid and drastic alteration in logical conditions.

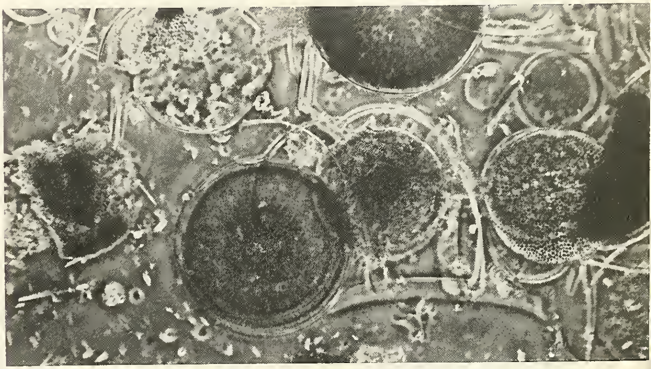
XTENSIVE analysis of the Lamont collection of cores has led to three jor conclusions:

(1) The ocean bottom is much more ve than has been believed hereto- e, and the bottom changes over the rs nearly as radically as do the faces of land masses under the in- ences of geologic processes.

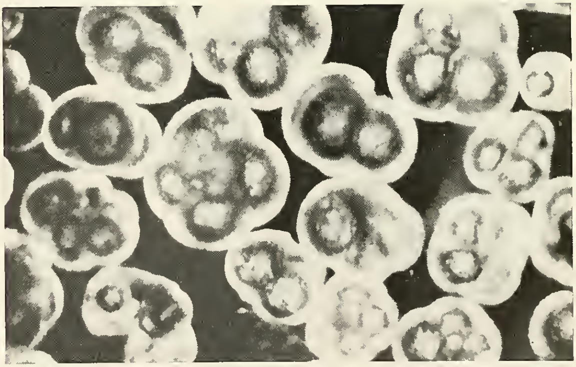
(2) Studies of cores that contain nplete and continuous sedimentary cords indicate that the last Ice Age gan about 60,000 years ago and



DIATOMS DISPLAY a striking variety of form. So many of them may occur in a given area that their fossils produce fairly thick deep-sea sediment layers.



MOST PROMINENT of the phytoplankton, diatoms are unicellular algae. Despite abundance, they may not be present in regions where index fossil is needed.

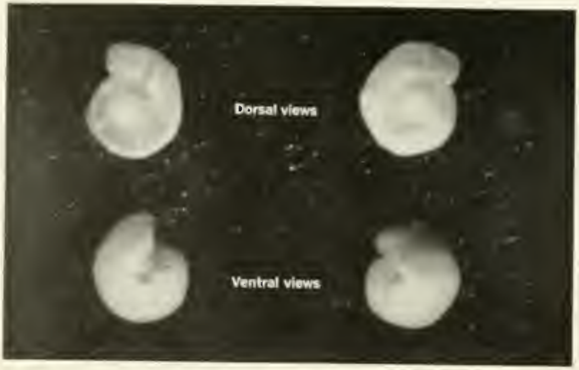


IN PHOTOMICROGRAPH are foraminifera *Globigerina pachyderma*, which can be used as climatic indicators in arctic and subarctic bottom sediment cores.

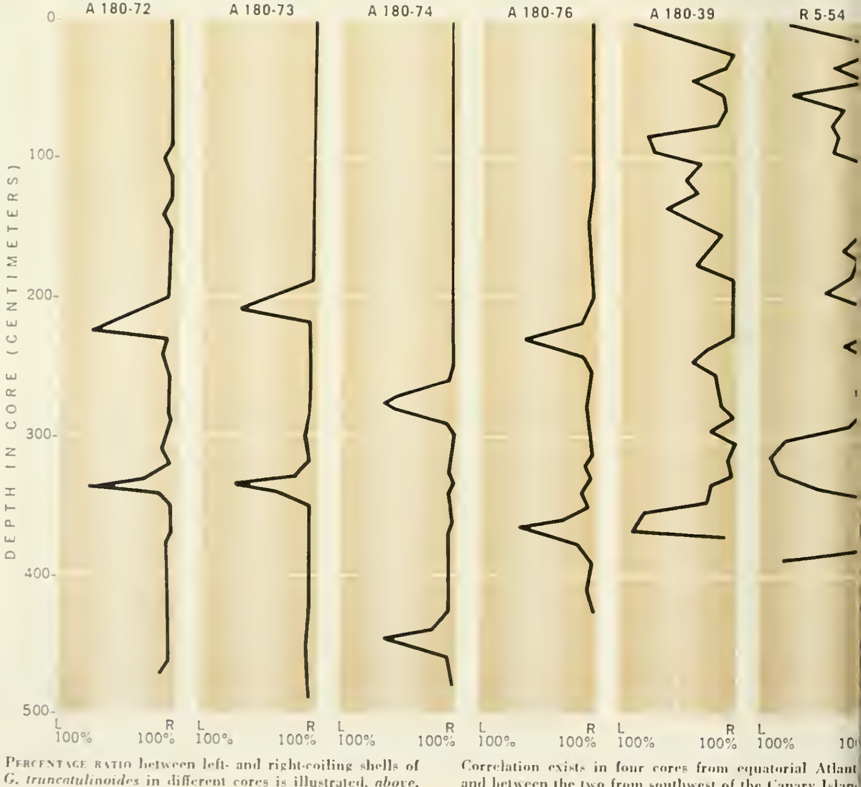
ended 11,000 years ago, rather t
20,000 years ago, as had been ge
ally believed.

(3) Two observations—the ap
ent absence of sediment older than
million years and the restricted th
ness (900 to 1,100 meters) of un
solidated sediment in the Atla
Basin, as determined by seis
methods—suggest that large-scale
organization of the Atlantic Basin t
place in the Mesozoic era, about
million years ago.

Old sediment cores from off B
muda contain fossil, shallow-wa
species of clams in the genus *Inoce
mus*, which are known to have exis
only in the Upper Cretaceous geolo
age of 100 million years ago.



Left- or right-coiling property of the shells of *Globorotalia truncatulinoides* helps to correlate the different strata of sediment (left-coiling shells are at left). Dorsal view of test shows the coiling, which looks reversed in ventral view.



Percentage ratio between left- and right-coiling shells of *G. truncatulinoides* in different cores is illustrated, *above*. Correlation exists in four cores from equatorial Atlant
and between the two from southwest of the Canary Islan

ings from studies of these cores in- te that Bermuda is the only known l in the Atlantic Ocean that has ained in a stable position for more 100 million years.

ome of the cores brought up from ocean bottom at a depth of about 0 meters off Bermuda contain se-grained volcanic rock, which rs when molten lava has had time ol gradually. Smooth-grained vol- ic rock indicates that the lava ed quickly, as in sea water.

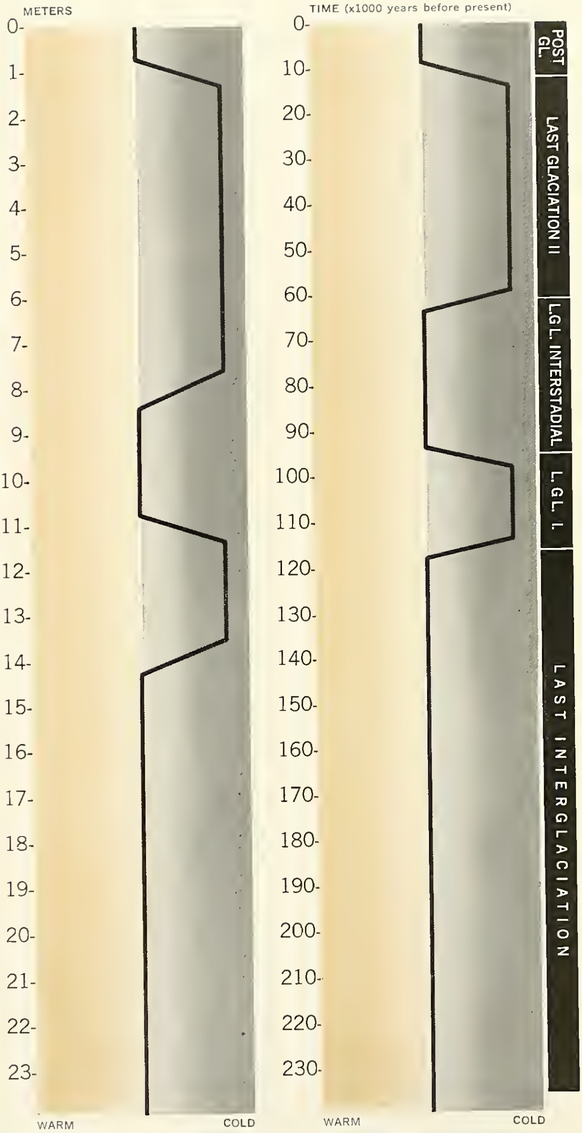
rom this it can be concluded that original volcanic island must in outh have attained a considerable ht above sea level. Subsequently, mountainous island, with coarse- ned igneous rock at its core, was ced by subaerial and wave ero- to a broad platform close to the l of the sea.

ne of the two cores from record th (7,955 meters) in the Puerto Trench is three meters long, and other is four meters. Both of these s have three graded layers of sand. most startling find is that the ds contain organic remains of a n alga known as *Halimeda*, indi- ng that the material composing the ds is of shallow-water origin, be- se *Halimeda* needs sunlight, and sunlight can pierce through a depth ,955 meters of water. The presence *Halimeda* and the remains of other anisms known to live only in shal- water in the sand layers indicate t the sands must have been trans- ted from shallow water off Puerto o to the bottom of the trench by bidity currents.

ONTINUED progress in oceanographic research is essential to our derstanding the world in which we . and as a basis for the use of tapped resources of the oceans—im- nse reservoirs of material wealth t will be available to man.

For instance, if high-grade steel tinues to be the basic metal in our lustrial civilization, manganese, es- tial for its manufacture, may ntually be recovered from sub- rine deposits. It has been estimated t 200 billion tons of manganese ide occur on the bottom of the cen- l part of the southeastern Pacific.

That the oceans are great reservoirs minerals, power, food, and various ganic products is clear. Gradually, we learn more and improve our hnology, these riches will be tapped.



GENERALIZED CLIMATIC CURVE of late Pleistocene is related to the average deep Atlantic sediment thickness, at left. Same curve is shown at right in relation to time, dating interglacial and glacial periods. Greatest average rate of sedimentation occurred during periods of glaciation. Data indicate average rate of 10 cm. per 1,000 years, not 1 cm., as was previously believed.

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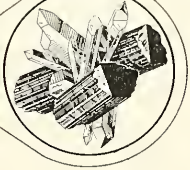

NATURE IN ROCK & MINERAL

By PAUL MASON TILDEN

E AVOCATION of the rock and mineral collector overlaps to some ex- that of his more specialized brother. amateur lapidary. The lapidary ds his leisure hours with the dia- d saw and various oils, abrasives, polishing powders, cutting and hing the semiprecious stones un- red by the rockhound in his ram- gs. However, the rockhound himself dabbles in the stonecutting art, and work of both these hobbyists not in- uently equals or surpasses in gen- excellence that of the professional cutters.

ne of the powders used in the gem- ing operation—the final polishing ess that achieves an admired mirror-finish on curve and facet—is an e of one of the so-called rare earths, um. The use of the adjective "so- d" is deliberate, for cerium is her an "earth" nor especially rare. tually belongs to the group of metals occupy positions 57 through 71 ussian chemist Dmitri Mendeleev's brated periodic scheme of the natural nents, familiar from the days of high ol chemistry and physics. The term e earth," which dates from the ear- days of elemental chemistry, is no er much used; modern practice has stituted the more accurate phrase "rare element." (Element numbers 21, scandium, and 39, yttrium, are sometimes included among the rare elements on the basis of similar physical and chemical properties. It might also be noted that element 61, promethium, occupies a rung of instability on the ladder of the elements; for practical purposes it is nonexistent in nature.)

We have said that cerium is not an especially rare element, and it is not, although it constitutes only an estimated .00155 per cent of the earth's crustal material. Even in this tiny proportion, however, it is more plentiful than such "common" elements as mercury, cadmium, tin, bismuth, or tungsten. On the other hand, a number of the rare elements are truly rare; europium, for example, whose relative abundance in the earth's outer crust is placed at .00001 per cent—one atom out of every hundred thousand of other elements.

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an alloy composed of all the rare
ments, plus a small percentage of
served admirably as the flint in
and cigarette lighters, producing a
cade of sparks when suddenly ab
by a roughened steel wheel. A
amount of this alloy, known to the
as misch metal, is used every year by
nation's smokers. Since the rare elem
are invariably close associates in na
analysis of a lighter flint would show
element cerium well in the lead qu
tatively, followed—but not very clos
by neodymium, lanthanum, dyspros
samarium, ytterbium, and the bal
of the rare-element suite.

For several decades the optical
makers of the nation have been ex
menting with the rare eleme
lanthanum in particular, in lens-g
manufacture. Rare-element glass
used considerably during World Wa
in such instruments as aerial cam
and gun sights. The rare-element con
nents of the glass facilitated produc
of high-aperture lenses of relati
simple design. During the "peace"
has been maintained so precario
since that war, the increased product
and use of rare-element glasses of h
refractive index and low light dispers
has placed "high-speed" lenses at
disposal of millions of camera fans, e
those who are in the most humble
financial circumstances.

FURTHER uses for the rare eleme
have been found in the steelmak
industry, where misch metal has b
widely applied to the improvement
ductility and impact properties of s
castings. The steel industry alone
counts for the yearly use of more t
a million pounds of rare-element c
pounds. Fabricators of magnesium
aluminum have found the high-temp
ature characteristics of their produ
benefited by small doses of the ra
element metals as alloys. Even more

ly the isotopes of at least two of
rare elements—samarium and ytter-
ı—have been employed as radiation
ces in portable X-ray machines de-
ed for operation in areas where elec-
ty is not available. While the
ation produced by these elements is
rted to be only 1 per cent or so of
produced in conventional X-ray
ces, pictures are at least readable,
in the words of their developers
ter than nothing in emergencies."
ıe use of cerium oxide as a superior
hing agent in the gem-cutting trade
hobby has been mentioned; com-
ially, large quantities of this rare-
ent oxide are used in both the
-glass and ophthalmic-glass indus-
for polishing purposes. It might be
tioned that there is an interesting
naly connected with the use of ceri-
oxide as a polishing agent for both
and many gemstones; its merit is
ıestioned, but science has yet to ex-
ı the reason for its efficiency. Ceri-
oxide is an impalpably fine, soft
der—but then, so is talcum powder!
ıe number of minerals in which the
elements are either constituents or
ssories is surprisingly large. Most
ıem occur, however, only sparingly,
t few localities, and thus the col-
ons of even the most knowledgeable

rockhounds are likely to lack all but the few most "common." Among the latter are the minerals of the microlite-pyrochlore series—complex tantalates and columbates of sodium and calcium—that are probably a little more common in some of the nation's granite pegmatite localities than is generally thought, especially in those areas that show a lithium-mineral phase or possess extensive segregations of high-sodium feldspars like cleavelandite. It is quite likely that both these rare-element minerals are frequently overlooked by collectors in the lithium pegmatite districts of such states as Maine, New Hampshire, Connecticut, South Dakota, or California because of their ordinarily minute crystal sizes and rather undistinguished colors.

Others of the "commoner" rare-element minerals are fergusonite, an oxide of yttrium, erbium, columbium, and tantalum; samarskite, a columbate-tantalate of the rare elements and calcium, iron, uranium, thorium, and a half-score or so of other heavy elements; euxenite, a titanate-columbate of the rare elements and uranium and thorium; and monazite and bastnasite, which will be mentioned again below. Perhaps one of the reasons that the rare-element minerals are so poorly represented in many amateur collections is their general lack of eye-catching coloration. Colors run largely toward nondescript dark reds, yellowish reds, various undistinguished shades of brown, and on into dull black. A better field clue to suspected rare-element minerals would perhaps be specific gravity, which runs from fairly high to very high, as might be expected in such combinations of the heavy elements.

Paul Mason Tilden, editor of the National Parks Magazine, began this column on the staff of Nature Magazine and is continuing it here.

In the United States the rare elements of commerce are almost entirely derived from the minerals monazite and bastnasite; small contributions have been made from time to time by the mineral euxenite, found in the placer districts of Boise County, Idaho.

Monazite is essentially a phosphate of the rare elements cerium and lanthanum, with the usual suite of less abundant rare elements. It is primarily a mineral of intrusive granites and ordinarily occurs as tiny, formless grains of yellowish-brown or reddish-brown tints scattered sparingly throughout such rocks. (It has been found in very large crystals and masses, however, in some

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pegmatites or "giant" phases of granitic intrusions; notable in this respect is the so-called Harding pegmatite in northern New Mexico's Rio Arriba County where large and well-formed brick-red crystals are not uncommon.)

In the southeastern United States various forces of erosion, operating in a relatively warm climate, have eaten deeply into the granitic rocks of the Appalachian highlands, dissolving those rock constituents soluble in natural acids and carrying insoluble mineral grains seaward. Thus the Atlantic coastal plain from Virginia to Florida has, over the ages, accumulated a vast volume of relatively indestructible granitic minerals as beach and continental shelf sands—quartz, magnetite, and ilmenite, predominantly, and, in smaller proportion, zircon and the rare-element mineral monazite. The beach sands of the southeastern states have become, through weathering of the hinterlands, a great ore-bank for two minerals that are growing in importance to the jet and atomic age: ilmenite, which furnishes titanium for high-temperature machinery, and monazite, whose rare elements will most certainly play a vital role in the technology of the future.

WHEREVER there are granitic rocks there is likely to be monazite, even if in minute quantity. But consider the occurrence of the mineral bastnasite, the fluocarbonate of cerium, lanthanum, neodymium, and dysprosium. Bastnasite, the only other important source of the rare elements in this country, has been reported from only eleven localities in the world—a really scarce mineral. Ten of the localities are commercially unimportant, and have produced bastnasite only as a mineralogical curiosity.

The eleventh locality, in the arid Mountain Pass district of southern California's Mescal Range, some sixty miles southwest of Las Vegas, Nevada, has on the other hand been characterized by geologists as "the greatest concentration of rare earths known in any type of rock or district in the world." Here is an estimated potential reserve of some ten billions of pounds of rare-element oxides, largely represented by the mineral bastnasite, and to a smaller extent by monazite and parisite. (This latter is a fluocarbonate of calcium and a member of the rare-element suite.)

Like a number of the mining districts of the nation, the Mountain Pass area went through several phases of activity before finally blossoming into a position of national significance.

Shortly after the War between the States, the area was prospected and worked for silver, copper, lead, and gold, and continued in active production for thirty-odd years. Then, after a lapse of twenty more years, World War I spurred

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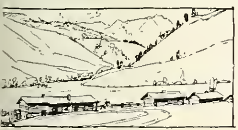

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the district into renewed production, this time for copper, lead, and zinc. After the war, activity slumped again. In 1933 the increased price of gold brought a new flurry of prospecting, and the district produced some of that metal before slipping once more into obscurity.

In 1949 a small group of prospectors combed the area with a Geiger counter, and finding intense radioactivity (probably emanating from the thorium mineral thorite, which is associated with the rare element ores of Mountain Pass) they brought out samples of a heavy, brownish mineral that they were unable to identify in the field. A technician of the U.S. Bureau of Mines analyzed the samples and declared them to be bastnasite.

Further investigation revealed vein after vein of the mineral over an area measuring at least 6 by 1½ miles. As word of the find spread, prospectors moved into the district in force. Mining engineers and representatives of large metal-producing companies also moved in with offers for the richest claims; today this rare-element bonanza is operated by one of the dozen or so domestic firms that cater to the nation's ever-increasing demand for the rare elements.

THE RARE ELEMENTS

Atomic No.	Element	Symbol	Atomic Weight
21	Scandium*	Sc	44.96
39	Yttrium*	Y	88.92
57	Lanthanum	La	138.92
58	Cerium	Ce	140.13
59	Praseodymium	Pr	140.92
60	Neodymium	Nd	144.27
61	Promethium	Pm	145†
62	Samarium	Sm	150.35
63	Europium	Eu	152.0
64	Gadolinium	Gd	157.26
65	Terbium	Tb	158.93
66	Dysporsium	Dy	162.51
67	Holmium	Ho	164.94
68	Erbium	Er	167.27
69	Thulium	Tm	168.9
70	Ytterbium	Yb	173.04
71	Lutetium	Lu	174.99

*Sometimes considered as rare elements on the basis of similar properties and associated occurrences.

†Configuration unstable; non-existent in nature. Atomic weight value indicates mass of the most stable known isotope.

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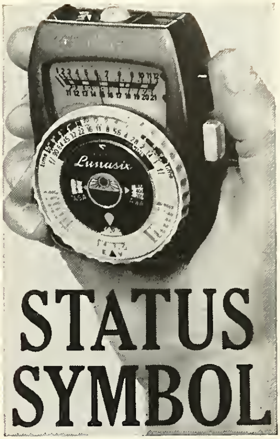

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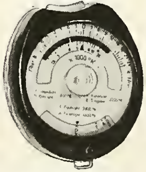

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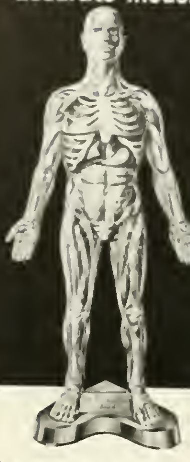

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About the Authors

A new and fertile area of co-operation between technology and biological science is explored by Dr. Dwain W. Warner in the article beginning on page 8. Dr. Warner is Associate Professor of Ornithology at the University of Minnesota, and he is also Curator of Ornithology at the Minnesota Museum of Natural History. He and Mr. William Cochran, Director of the Bioelectronics Laboratory at that museum, have been working for some time on the development of instruments to aid investigation of bird migrations.

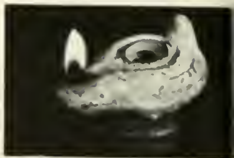
Stranger-than-fiction facts are presented and some misconceptions are punctured in "Success Story of the Opossum," by Dr. William J. Hamilton, Jr., Professor in the Department of Conservation, New York State College of Agriculture at Cornell University. Dr. Hamilton has made exhaustive studies of the animal and of its habits.

Three years of living and sailing with Micronesians led to Mr. John Henry Brandt's observations on their navigation methods, starting on page 26. Mr. Brandt, a graduate of Tulane University, conducted an expedition into central New Guinea in 1959. He lives now at Songkhla, Thailand, while on a tour of duty with the U.S. Public Health Service. He also spent six years among Indian tribes of the southwestern United States.

Dr. John F. Haskins, author of the article about artifacts of the second century B.C. in the Chinese kingdom of Tien, is Assistant Professor of Art History in the Department of Archeology and Art History at Columbia University. Dr. Haskins has traveled through Russia, Siberia, and Central Asia, and was in China during World War II.

A Research Fellow in The American Museum's Department of Ornithology, Dr. William G. George is now in Peru, pursuing his studies in avian anatomy and taxonomy. The color picture that appears with his discussion of the rarely photographed olive warbler was made by Dr. Eliot Porter, well known as a photographer of many aspects of nature. He is also in Peru at present, photographing birds.

Messrs. David B. Ericson and Goesta Wollin, co-authors of "Time's Traces in Sediment," are, respectively, a geologist with the Lamont Geological Observatory and a research consultant at the observatory. Mr. Ericson has studied sediment cores extensively and has been with the observatory since it was founded in 1949. Mr. Wollin's vocations include deep-sea research and work as a consultant to the National Council on Crime and Delinquency.



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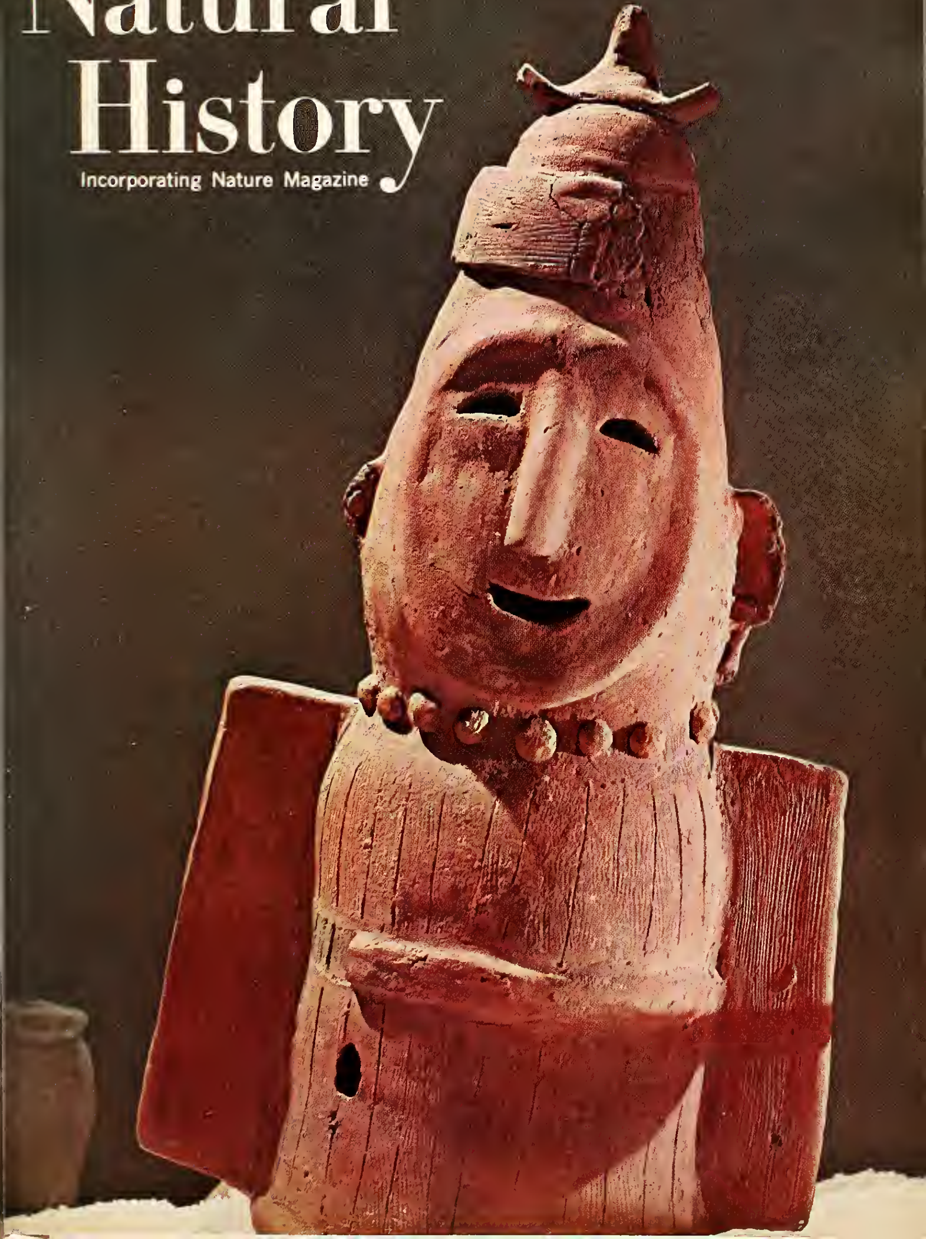

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COVER: Crude, terra cotta figure with a shield was made in Japan during the first to sixth centuries A.D. Thousands of these clay cylinders, or *haniwa* were placed on the burial mounds of the time and many, such as this one represented persons or objects the deceased was believed to require in the afterlife. With *dogu*, a household fertility figurine, *haniwa* constitutes part of the islands' primitive art, whose origins date to Neolithic times. Sculpture and pottery of Japan's pre-Buddhist period are discussed in the article beginning on page 38. Cover and photographs for the story are by Lee Boltin.

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York 24, N. Y. Published monthly, October through May; bimonthly June to September. Subscription Price: $5.00 a year. In Canada, and all other countries: $5.50 a year. Single copies, $.50. Second class postage paid at New York, N. Y., and at additional offices. Copyright, 1963, by The American Museum of Natural History. No part of this periodical may be reproduced without the written consent of NATURAL HISTORY. The title NATURE MAGAZINE, registered U.S. Patent Office. Unsolicited manuscripts and illustrations submitted to the editorial office will be handled with all possible care, but we cannot assume responsibility for their safety. The opinions expressed by authors are their own and do not necessarily reflect The American Museum's policy.

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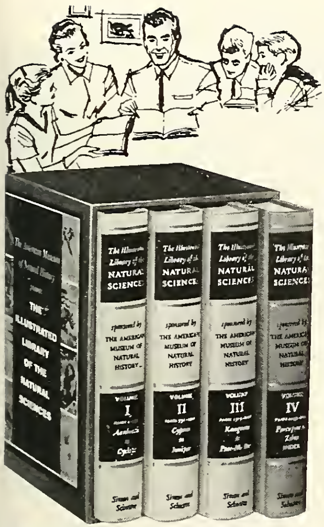
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Reviews

Four men who helped to win the West

By NORMAN D. NEWELL

GREAT SURVEYS OF THE AMERICAN WEST, by Richard A. Bartlett. *University of Oklahoma Press, $7.95; 408 pp., illus.*

THE discovery of gold in California near the middle of the past century precipitated one of the greatest mass migrations of modern times, and the public demand for knowledge of the western wilderness of the United States could not long be denied. The government had already sent several small exploring parties into the West under Lewis and Clark, Zebulon Pike, Stephen H. Long, John C. Frémont, and others. At the same time, Jefferson Davis, then Secretary of War, acted through the Army Engineers and encouraged a number of railway surveys aimed at finding the best routes across the continent. These early surveys were not co-ordinated, had very limited objectives, and served mainly to emphasize the haze of ignorance and mystery that then blanketed the West.

Following the Civil War, a great new wave of emigrants headed westward from the Prairie States into a vast land known to the general public mainly through grossly exaggerated and romantic accounts by untrained observers. The crucial need for accurate and detailed knowledge about the western two-fifths of the nation lying beyond the one hundredth meridian soon resulted in a crash program for exploration of the West. Four elaborate geographical and geological surveys were sponsored by the federal government between 1867 and 1879. These "great surveys" concentrated their efforts on the Rocky Mountain region and the Great Basin. For the first time they provided accurate information of this mountain and desert wilderness at a bargain rate of less than two million dollars. The findings added greatly to American prestige in the world of science and provided the impetus for colonization of the West.

The four remarkable men who conceived, organized, and led the great surveys were Ferdinand Vandeveer Hayden, Clarence King, John Wesley Powell, and George Montagne Wheeler. These were the real heroes of the old West. Yet their names are scarcely known today to a public fascinated by the glamorized and imaginary exploits of early desperadoes and lawmen. Indeed, few historians have understood the massive contributions made to the welfare of the United States by these men and their separate organizations.

Now, the story of the Hayden, King, Powell, and Wheeler organizations and their role in the winning of the West has at last been brought together by a competent historian and in a single volume. In Richard A. Bartlett's *Great Surveys of the American West*, the story is told with outstanding perception and scholarship in the fine tradition of Bernard De Voto and Wallace Stegner. There is an abundance of romantic adventure and excitement of scientific discovery told, in part, in the words of the explorers. Of deeper meaning, however, is the light this book sheds on the men and the manner in which they advanced basic science and made known the wilderness with their accurate maps and painstaking observations. Through their expert knowledge, they recognized the need for careful, long-range planning in land management and conservation of natural resources—grasslands, timber, soils, minerals, and, especially, water.

During the 1870's, many of the leading American and a few European biologists, paleontologists, and geologists were directly or indirectly involved with the work of these four surveys, and a listing of their names is a "Who's Who" of American science of the period. Western flora and fauna, geology, paleontology, and Indian cultures were discussed in admirable reports, which to this day form the foundation of knowledge about these mountainous and desert regions.

For eleven years, from 1867 through 1879, Hayden and his men explored, mapped, collected, and classified, laying the foundations for much of our scientific knowledge of Nebraska, Wyoming, and Colorado. The work of the Hayden Survey was brought to the general public through popular articles and magnificent wet-plate photographs by W. T. Jackson and oil paintings by Thomas Moran. Hayden's recommendation to set aside the Yellowstone region in Wyoming, Montana, and Idaho for a national park

DR. NEWELL, Chairman and Curator, THE AMERICAN MUSEUM Department of Fossil Invertebrates, is a geologist. He is currently much interested in many problems of animal extinction.

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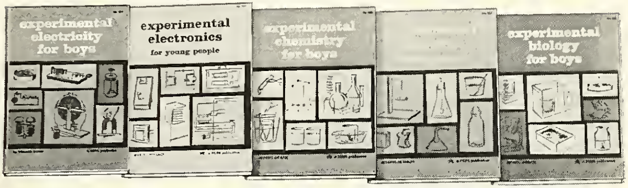
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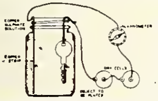

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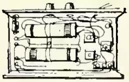

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was immediately adopted by an enthusiastic and co-operative Congress.

Clarence King had the grand and logical idea to survey a strip one hundred miles wide through some of the most inhospitable country in North America, stretching across the Rocky Mountains and Great Basin along the fortieth parallel and including the routes of the Union Pacific and Central Railways. The area covered parts of the present states of Colorado, Wyoming, Utah, and Nevada. The survey operated from 1867 to 1878 and resulted in seven quarto volumes of scientific data.

The Powell Survey, 1870-1879, was concerned mainly with the little-known plateau country of Arizona and Utah, and he emerged as one of the foremost scientific leaders of the nation. He tried hard to break down popular misconceptions about the West, and he sought legislation that would insure sensible utilization of its desert and mountain regions. He and his men classified the terrain that they surveyed as mineral, coal, timber, pasturage, or irrigable lands, and he showed that each of these would require different laws. He originated a general scheme of land classification, reclamation, and water conservation that has influenced federal legislation down to the present time.

After the Civil War, when the army again turned its attention to exploration, the generals discovered that civilian surveys had moved into the vacuum left by the army's withdrawal from this activity. With the objectives of re-establishing its primacy in geographic studies essential for military strategy, the War Department, in 1871, established a survey under the command of Lieutenant Wheeler. The King Survey was also supported by the War Department, but was wholly independent of the army.

Between 1871 and 1879, Wheeler and his men studied and mapped a vast desert wilderness in California, Nevada, Utah, and Arizona, including considerable parts of the areas under study by the competing civilian surveys. He ascertained, "as far as practicable," everything relating to physical features, climate, mineral and agricultural resources of the country. He also made observations on the Indians, then a primary responsibility of the army, but topographic mapping was his chief activity.

Wheeler had hoped to complete the exploration and rough mapping of all of the states and territories west of the one hundredth meridian within a period of fifteen years at a cost of not more than two million dollars. He did not, however, accomplish this Herculean task, which even today, has not been finished.

This was a period of trial and error in governmental support and administration of science. The waste and duplication of effort inherent in competing governmental agencies could not continue for long. In response to persuasion from Powell and other members of the scientific community, Congress investigated the situation, disbanded the three remaining surveys in 1897 (King had already finished his work), and established the United States Geological Survey as an agency of the Department of the Interior. The ideas expressed by the four farsighted men are only now, when it is almost too late, gaining general acceptance, after more than eighty years of abuse of the land. Anyone who wishes to understand the nature and problems of the American West will surely benefit from reading *Great Surveys of the American West.*

THE POLES, by Willy Ley. *Time Inc., $3.95; 192 pp., illus.*

MORE than a nature book, *The Poles* covers not only the natural history of man's impact on these regions but, conversely, the impact of the polar regions on man. The text by Willy Ley is well written and the photographs are magnificent. Unfortunately, the picture stories inserted here and there throughout the book are typical *Life* productions and leave a good deal to be desired by the thinking reader. Indeed, some of them seem quite inappropriate to the major part of the text. Pictures of school chil-

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dren in Anchorage and homesteaders in well-forested country hardly add to one's appreciation of the polar regions.

The organization of the rest of the text is most satisfying, as it gives a clear, succinct picture of the various aspects of the polar regions: opening with a description of these areas as we now know them and moving on through a history of man's attempts to reach the poles. Excellent descriptions of Arctic and Antarctic flora, fauna, and geology are included. The text ends on a note of speculation and prediction regarding the future of these regions as man's inexorable drive for expansion continues.

T. K. SHARPLESS

THE AMAZON, photographs by Emil Schulthess; text by Emil Egli. *Simon and Schuster, $15.00; 208 pp., illus.*

THIS beautifully illustrated book (with two maps and 83 black-and-white photographs plus 79 in color) of 53 unnumbered pages of text, presents a *vol d'oiseau*—a colorful account of a vast region of northern and central South America—translated into English under the incomplete title *The Amazon*.

The title is misleading, for the great river is supposed to be a common denominator to all the places and people dealt with, yet some portions of the book have little, if anything, to do with the Amazon. For instance, neither La Paz nor Brasília is in the Amazon Basin.

In the preface are all the commonplaces about the "green hell." These comments inevitably bring to mind the words of Gordon MacCreagh, who said in his wonderful South American travel book, *White Waters and Black*, that adventure is in the man, not in the event.

Although the photographs are really magnificent, and the aspects chosen are largely unhackneyed, the large map is grossly inaccurate. The limits of the Amazon Basin as depicted do not correspond with fact. The towns and settlements shown are not necessarily the largest or most important, as one would think from the caption, but are those either referred to in the text or used as subjects of photographs. The concept of "dry forest," as we deduce from the map, does not agree with either the scientific or the popular one, and other geographical locations are only crudely located.

The text is rather good, with most of the Spanish and Portuguese names rendered correctly, but it is not well balanced. Some subjects are treated with a detail that is inconsistent with other portions. For example, in the discussion of the origin of the Amazon Basin and the buildup of the Andes, the treatment is too general to be accurate and too long to be popular. In some instances, it is impossible to tell if a discussion concerns an over-all viewpoint or a par-

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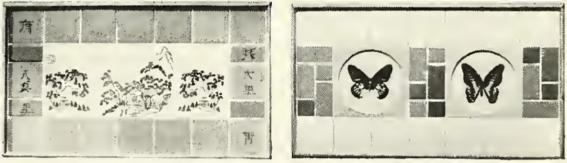

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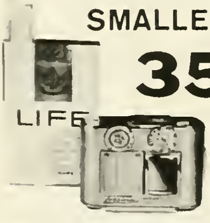

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ticular example, as in the section concerning the migration of man across the Bering Strait and subsequently to South America. If the example refers to one particular event, it is not made clear; if it is supposed to show the general phenomenon, the time scale is 20,000 years out of phase.

The reader who is not perfectly familiar with each region is confronted with a tangle of references to weapons, habits, and names of tribes, and may not be able to distinguish among them.

Besides some minor factual mistakes—Manaus was not the first town in South America to have electricity; it was Campos—the book contains a great deal of useful, up-to-date, and accurate information about that part of the world.

FERNANDO PIRES

WHOSE WOODS THESE ARE, by Michael Frome. *Doubleday & Co., $5.95; 360 pp.*

EVERY once in a while you come across a book that ought to be good, but isn't. The subject matter is interesting and important; the author has obviously done painstaking research; but somehow the book as a whole doesn't jell.

But suppose, in spite of a rather pompous title, this reader plunges into the book and finds: "The National Forests encompass 14,000,000 glorious acres of wilderness, a large kingdom of the outdoors located in scattered segments. Roads, logging and the comforts of home are not permitted . . ." and then, in the next paragraph: "The National Forests are much related to the national economy. Hundreds of communities depend on their timber resources to keep sawmills going. In the sale of timber to private loggers, the Forest Service earns $140,000,000 a year for the government."

And what, indeed, *is* a National Forest? The book includes no definition, so the reader must make up his own mind—and may be wrong.

All this is too bad. There is a great deal of interesting and valuable information in this book—about Gifford Pinchot and the two conservationist Roosevelts, for example, and about the various forests themselves, as the author, a former newspaper writer, tours them from coast to coast. Here facts abound, and the mining of them obviously required considerable research. But the facts are not well organized, and the interspersion of philosophical and poetic ruminations doesn't make them more digestible or convincing.

As Frome points out, the National Forests comprise about one-tenth of our total land area. The author has apparently done a creditable job of exploring this area, but unfortunately he has not ably reported what he has seen.

PIETER FOSBURGH

SEABIRDS IN SOUTHERN WATERS, by Prince Philip, Duke of Edinburgh. *Harper & Row, $3.95; 62 pp., illus.*

DURING the past several years, Great Britain's Prince Philip has taken two long cruises in southern waters in the royal yacht *Britannia*. The log of these trips shows visits to such out of the way locations as Gough Island or Graham Land in Antarctica. One needs a hobby when traversing hundreds of miles of rough sea in a small boat, and the Prince found one—photographing birds. Indeed, he became so entranced by the penguins, albatrosses, boobies, and other seafowl that he wished to capture his pleasure permanently in this book. The engaging and informal text tells not only of the birds, but of the people, the geography, and the history of the islands visited. There is a sort of appendix with descriptions of the birds by Captain G. S. Tuck and drawings of them by Commander A. M. Hughes. Thus the book can serve as an introduction to at least the more common birds of the southern seas. The photographs, while they are attractive and well captioned, are all in black and white. The seabirds of Antarctica are fortunate to have found a royal champion.

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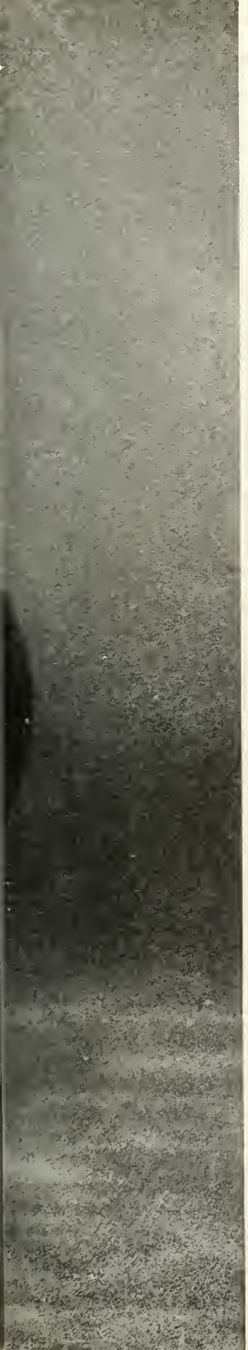
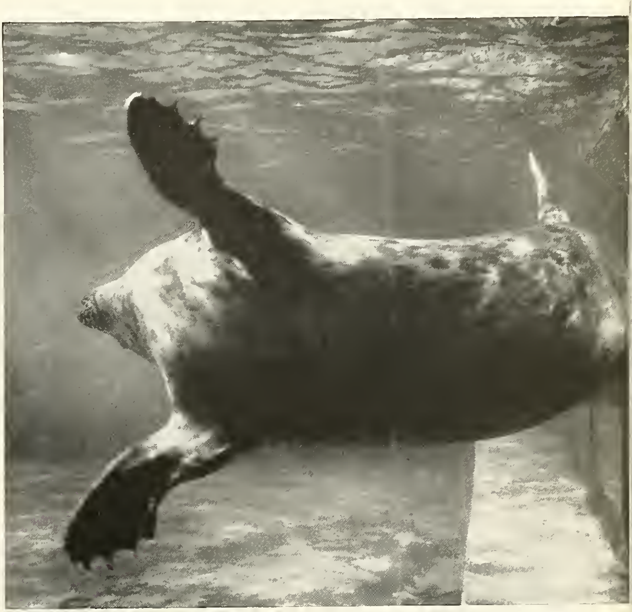




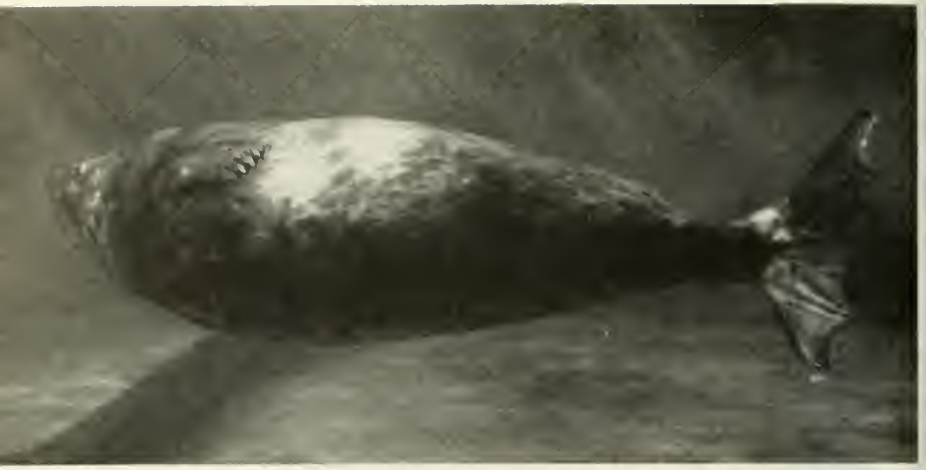
Gray seal on its back, at left, ends a power stroke of left flipper. Planing with its front feet, *above*, and rolling its body, seal turns sharply to right.

Locomotion in Pinnipeds

Swimming methods relate to food habits

By Carleton Ray

The "true" seals, eared seals, and walruses comprise three distinct families of the suborder Pinnipedia, which is in the order Carnivora. In plainer language, these marine mammals are set apart from the rest of the Carnivora as a group of species that have evolved for life in the water and are characterized by having the limbs reduced and modified for swimming. The rear flippers are wide and paddle-like; the foreflippers are usually tapered and pointed. Although the digits and nails, or claws, are still present in most pinnipeds, and although handlike grasping is still clumsily possible, these mammals behave like fish in that they swim with the extremities, steer with flippers and body, and catch food primarily with the mouth. They come on land or ice to whelp and rest, but "walk" only clumsily.



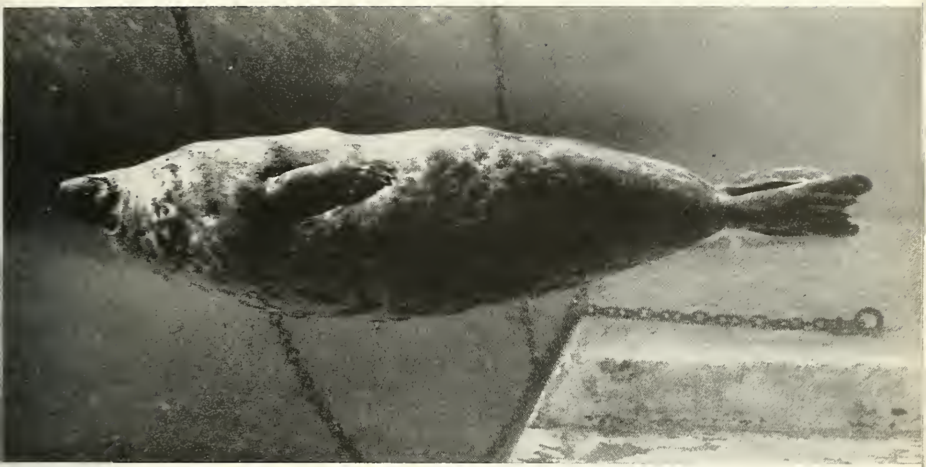
NECK of gray seal is telescoped, and body becomes compact, shortened, and torpedo-shaped for speed. The animal is swimming upside down in its tank.

THERE are other marine mammals besides the pinnipeds. The whales are best-known and most fishlike in that they look and act very much like large fish and never leave the water. The dugongs and manatees are specialized creatures of tropical and subtropical coasts and rivers. Sea otters and the extinct sea mink are (or were) more closely related to weasels than are the pinnipeds. None of these could be confused with the pinnipeds if the entire body were seen, but at sea the little doglike faces of the sea otters could perhaps be mistaken for those of the seals. However, this article is not meant to describe all marine mammals systematically; it is a discussion of pinnipeds as they appear structurally, of how they move on land, and also of the manner in which they move in their most natural habitat—under the water, where their grace and beauty can be best appreciated.

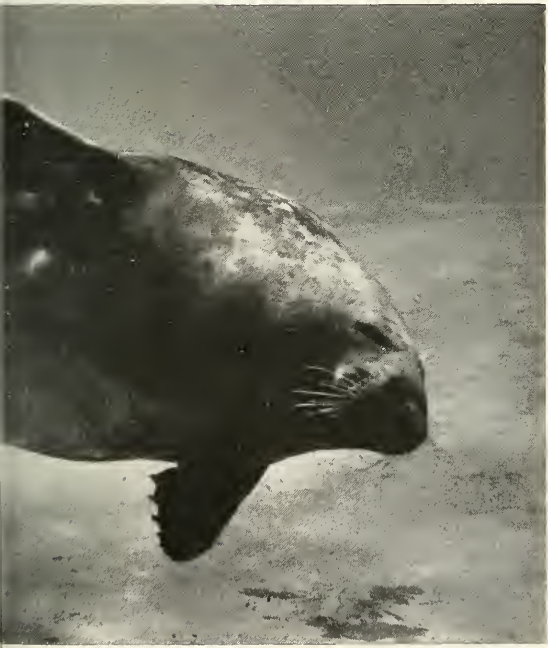
There is considerable confusion between the names "seal" and "sea lion." The true seals are properly pinnipeds of the family Phocidae, and are the pinnipeds with no external ears. They have doglike faces and rear flippers that cannot be turned forward. The opening of the ear, or external auditory meatus, is simply a hole located a little behind the eye, and within it are valves that apparently open automatically when the head is out of water and close when the seal submerges. Because the rear flippers cannot be turned forward, the animals cannot use them for locomotion on land. In fact, all that shows of the rear limb is the foot and ankle; the femur, tibia, and fibula of the hind leg are incorporated in the torpedo-shaped body. On land a true seal moves either with or without the aid of the stubby, relatively small, clawed foreflippers by a hunching, inchworm forward movement, which can be quite rapid. Or, frequently, locomotion is accomplished simply by repeatedly rolling over sideways. Therefore, a pinniped that cannot "walk" is a true seal, a phocid. There are eighteen full species of them, or seventeen, if the extremely rare West Indian monk seal *Monachus tropicalis* has actually been exterminated. Members of the various species are found in all seas from the Arctic Ocean through the tropics and into the Antarctic. The largest are the elephant seals, *Mirounga leonina*, and *M. angustirostris*, which may reach three tons in weight and over fifteen feet in length, and the smallest is the ringed seal *Phoca (Pusa) hispida*, which may be longer than five feet and more than two hundred pounds. A relative of the latter, the Baikal seal *Phoca (Pusa) sibirica*, is the only species of pinniped confined to fresh waters.

The lack of external ears, loss of efficient locomotion by means of the rear limbs on land, the method of loco-

WHEN BEGINNING to turn, seals mov
dorsally. Occasionally they can reac



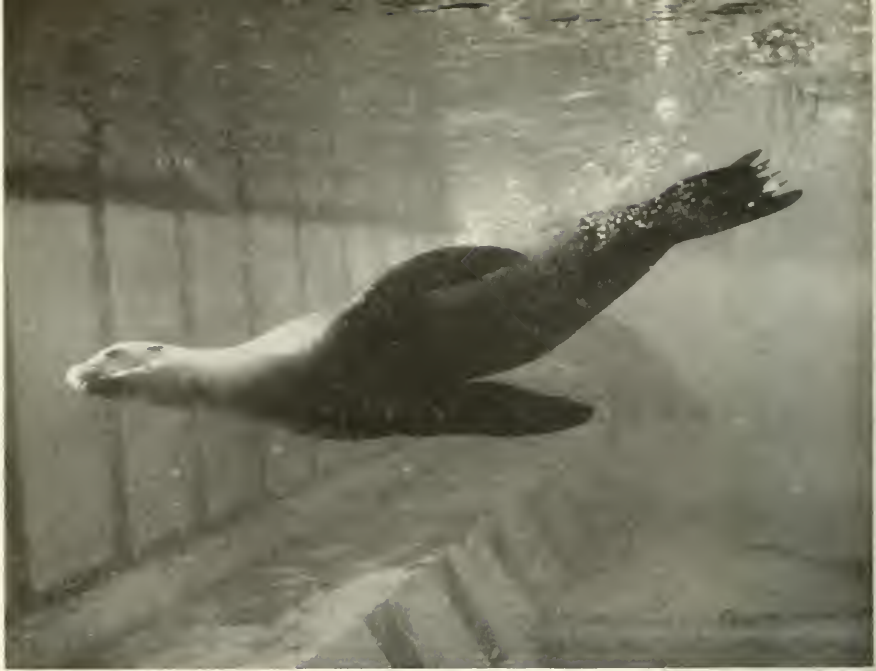
As it coasts through the water, gray seal's feet are relaxed. Along length of its body can be seen skin ripples—turbulence folds induced by the speed.



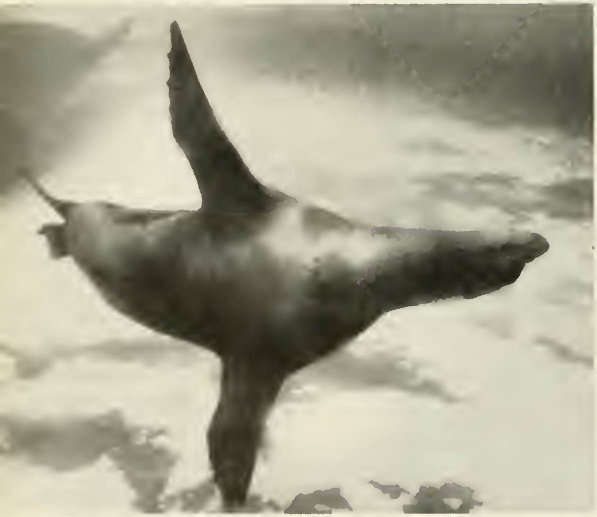
bursts of speed to eighteen miles an hour, but this is not long sustained.

motion in water, and the fact that they are the most numerous and widespread of pinnipeds, leads scientists to believe that phocids are the most highly specialized of the pinnipeds.

What we usually call "seals" in circuses and zoos are generally eared seals or, to name the most common species, California sea lions, *Zalophus californianus.* We are all familiar with the ball-balancing act of the circus "seal," the familiar guttural bark, the long-necked, erect posture, and the peculiar, loping run or walk in which the animal uses all four limbs. The California sea lion is even more doglike than are the true seals. It even sounds and looks somewhat like a dog. In this species and its relatives, there is a small external ear, or pinna, and for this reason the eared seals are called by the family name of Otariidae. The clawless foreflippers of otariids are long and pointed, rather like penguin wings, while the rear flippers are free to rotate forward under the body and are thus of use in land locomotion. Otariids are found most commonly in the temperate zones, but a few of the twelve species straggle into the tropics and the colder waters of the Arctic and Antarctic. Most of them breed in harems in the warm months, and the big bulls are two to three times the weight of the females. The largest otariid is the



Sea lion's front flippers are about to begin power stroke. Buoyancy is reduced by exhaling during the dive. (Note bubbles streaming from mouth.)

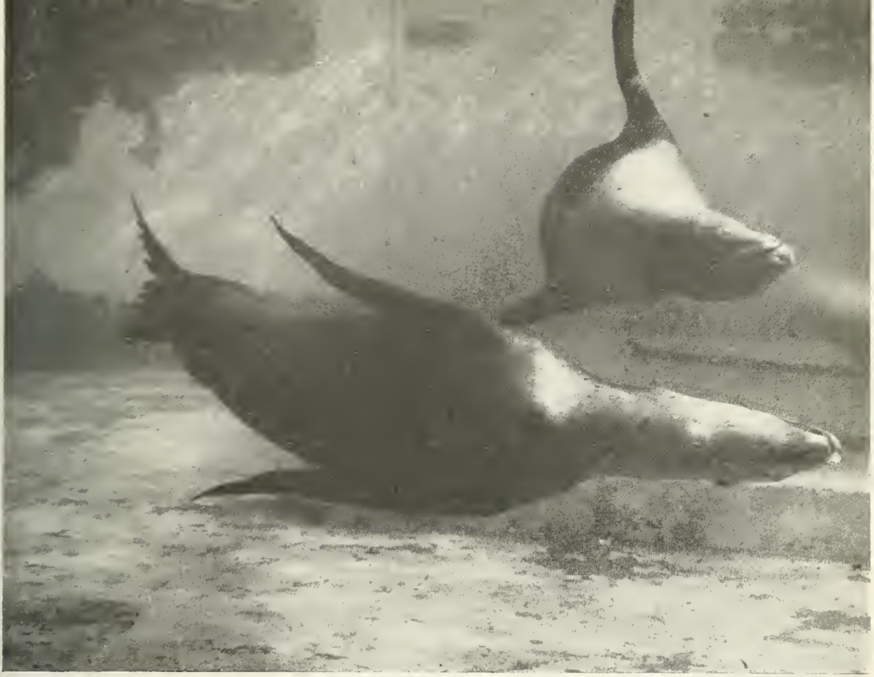


Like gray seals, the sea lion rolls to left as it turns. The spread flippers will be brought down forcibly for a stroke; the feet always trail behind.

northern, or Steller's, sea lion, *Eumetopias jubata*, of the west coast of North America and the Bering Sea; the males may weigh a ton.

Perhaps the most peculiar pinnipeds are the walruses, which are in a family of their own, Odobenidae. They are huge, tusked, and mustached, and are intermediate in some respects between the true and eared seals as follows: they have no external ears, but they do have powers of locomotion on land after the manner of eared seals since the rear flippers can rotate under the body. They "walk" on land, but in a blubbery, clumsier way than sea lions, as befits their size and looseness of structure. Further, the forelimbs are wide and stout and much larger proportionately than in seals, but bear only small nails. Lastly, they swim in a manner suggestive of both phocids and otariids.

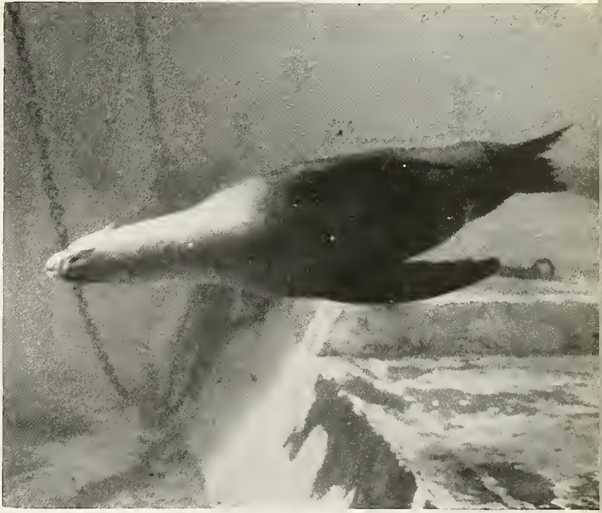
There are four principal populations of walruses that formerly were divided into two species, the Atlantic and Pacific. Now scientists recognize a single species, *Odobenus rosmarus*, with two subspecies. The populations



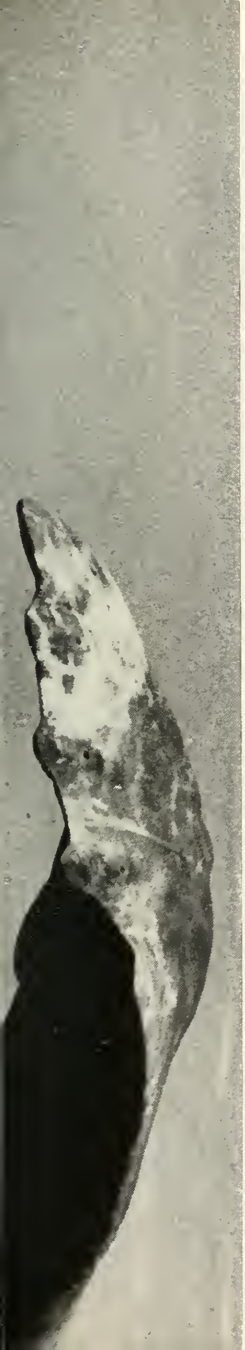
Two phases in the sea lion's power stroke are shown, *above*. At rear, the flippers are beginning to close down, while in foreground stroke is ending.

are all found on the southern ice fringe, in the subarctic in winter and the Arctic in summer as the ice melts and moves north. One population, comprised of the smallest walruses with the least-developed tusks, lives in eastern Canada and western Greenland. Males reach perhaps three thousand pounds and have tusks that rarely exceed twenty inches exposed. Two other populations, a little larger in size and tusk length, are found in the north of Europe and central Siberia. The fourth is a Bering Sea and Arctic Ocean group, and males of these reach at least 3,700 pounds with up to thirty inches of tusk exposed.

One factor that might explain the large size of walruses is their habit of bottom-feeding, mainly on shellfish. They do not have to be sleek and fast, but they must be powerful and enduring divers to "graze" on the bottom of shallow Arctic and subarctic seas. Most species of true seals and eared seals, on the other hand, are fish or squid eaters primarily (although some eat planktonic shrimp or bottom mollusks and crustaceans), so speed and maneuverability are important.



Power stroke has been completed and animal planes through the water with its feet held like airplane aileron to assist in its rolling to the side.



Walrus uses foreflippers in much the same way as does eared seal, but with less precision. Loose structure shows, *left* and *above*, as rear stroke begins.

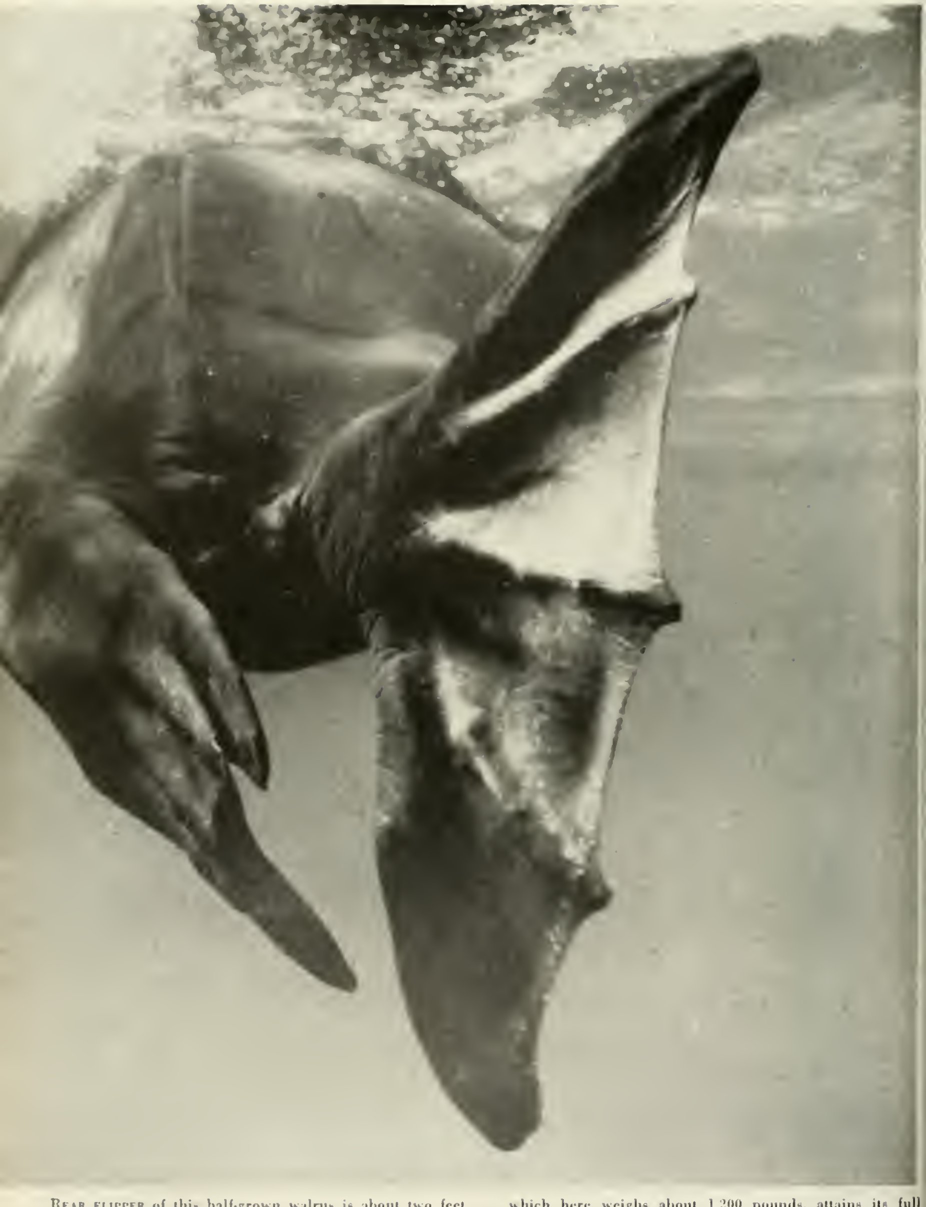
The history of pinnipeds is a considerable mystery. The earliest fossils are of the early Miocene, some thirty-five million years ago. By then, the three families were discrete and there is little to indicate their origins. Studies of both fossil and living species present many questions, and some scientists believe that the phocids were derived from a different source than were the otariids and odobenids.

The eared seals have the simplest method of underwater locomotion, although they are far speedier than the others. They employ only the long foreflippers for propulsion, rushing through the water in much the same manner as penguins, auks, or puffins. That is, the flippers are raised and then brought sharply down to their sides. The rear flippers trail behind, resting in such a position as to form a ventrally pointing V and, as such, probably have the effect of a rear stabilizer. Between powerful strokes of the foreflippers, the eared seal coasts with its flippers to the sides, forming a streamlined shape with little water resistance.

With this type of locomotion, the eared seals are able to attain at least fifteen and possibly seventeen or eighteen miles per hour, but such bursts of speed do not last long. The animal appears to be built for sprinting rather than for endurance.

True seals and walruses sometimes move by flapping the foreflippers, like the eared seals, but the true seals never do so for long periods of time. Frequently, they will "push off" by one or several foreflipper strokes; then the rear flippers take over in a fishlike fashion, while the foreflippers are folded against the sides for streamlining. The right and left rear flippers are used alternately, the left for strokes to the right, and the right for strokes to the left. The power stroke is against the "palm" of the flipper. This is similar to hand strokes by the human swimmer—the palm stroke is used for power, the return stroke is with the hand collapsed to offer minimum resistance to the water. The photographs on page 19 clearly demonstrate this side-to-side motion.

True seals are faster than walruses, yet I do not believe the fastest seal can travel much more than ten or twelve miles an hour, and most of the ten species I have observed average perhaps eight miles per hour or less while swimming in tanks at top speed. Both large and small walruses at the New York Aquarium have been clocked repeatedly. Two miles per hour or less is cruising speed, and four, or perhaps five, is possible for very short periods. If these speeds appear to be slow, it is well to remember that no aquatic animal is really fast.



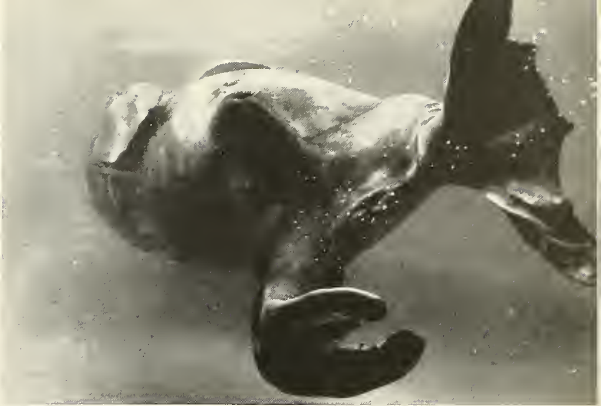
Rear flipper of this half-grown walrus is about two feet from top to bottom and will increase in size as the animal, which here weighs about 1,200 pounds, attains its full growth. Flipper action, while loose, is extremely powerful.

It requires a great deal more power to travel through the dense medium of water than through air, as both friction and water resistance must be overcome. Furthermore, the fish prey of most true seals and eared seals are even slower, few species attaining five miles per hour.

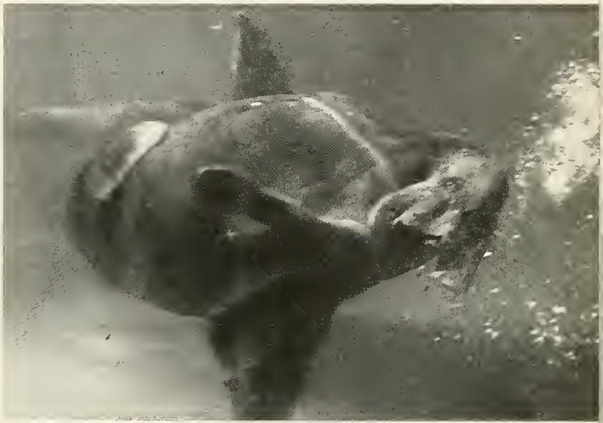
During sustained travel, the seals and walruses are notable for one other difference from the eared seals. The neck, especially in true seals, is telescoped and the vertebrae assume an S-shaped configuration. The body becomes compact, shortened, and torpedo-shaped. At times the true seals may be seen to extend their necks to look about or to strike at a fish, but this is usually quick and occasional, since the motion reduces speed by altering the streamlined torpedo shape and increasing surface drag.

The major difference between seal and walrus swimming methods lies in precision and variability. The walrus is, as noted previously, a very loosely constructed animal. Its rear flipper motions are less compact and refined than are those of the true seal. Further, the true seal's transition from one rear flipper stroke to the next is neat and rapid. The walrus is more liable to spread the rear flippers widely during change-over between strokes. Lastly, the walrus is more given to travel by means of foreflipper movements than are eared seals. Under water, particularly when grubbing about on the bottom, the foreflippers are also used extensively. A seal does not often do this, as its foreflippers are relatively small and powerless in the water. In sum, the eared seal uses the foreflippers exclusively for propulsion power. The true seal uses the rear flippers most of the time, although the foreflippers are used to push off. The walrus swims with variations on both methods, perhaps preponderantly like a true seal, but with considerably less of the latter's precision.

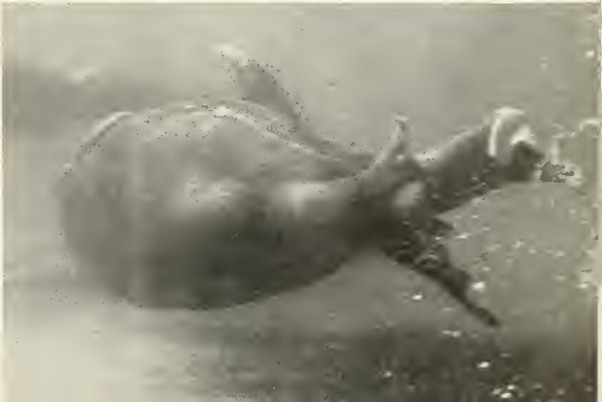
The walruses do not seem to swim for extended periods of time, preferring not to stray far from the southern edge of the sea ice pack where they rest. Certain herds, mostly males, haul out on rocky shores in summer and use these as resting places. It appears that walruses must come out of the water rather frequently to rest. Some true seals, however, are pelagic for parts of the year. This is true of the harp seal, *Phoca (Pagophilus) groenland-*

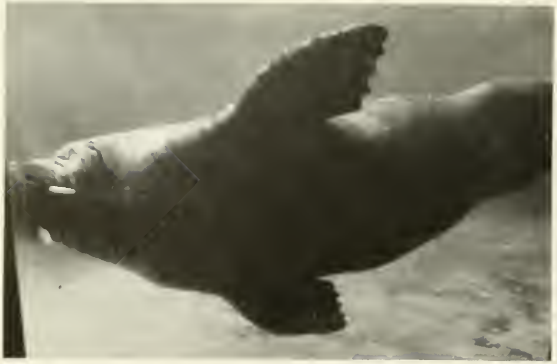


While swimming on back, entire rear section of walrus swings to the right as the right flipper begins to open and take over from the left flipper.



Left flipper is now folded, *above*, and right flipper begins stroke to left. Movement is completed, *below*, and body has begun to swing to the left.





BROAD FOREFLIPPERS are beginning to spread wide as walrus executes turn to its right. These animals seldom swim for extended periods of time.

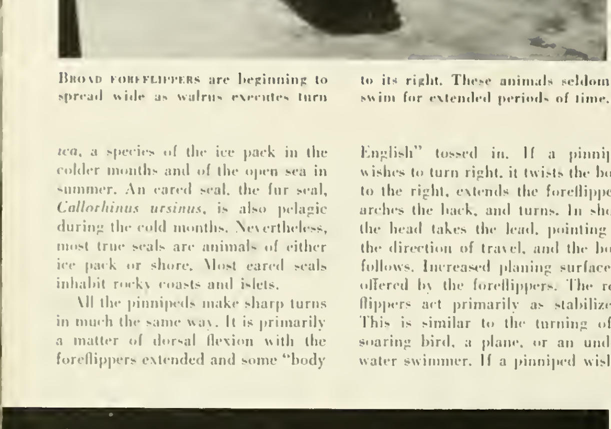
tea, a species of the ice pack in the colder months and of the open sea in summer. An eared seal, the fur seal, *Callorhinus ursinus*, is also pelagic during the cold months. Nevertheless, most true seals are animals of either ice pack or shore. Most eared seals inhabit rocky coasts and islets.

All the pinnipeds make sharp turns in much the same way. It is primarily a matter of dorsal flexion with the foreflippers extended and some "body English" tossed in. If a pinniped wishes to turn right, it twists the body to the right, extends the foreflippers, arches the back, and turns. In short, the head takes the lead, pointing in the direction of travel, and the body follows. Increased planing surface is offered by the foreflippers. The rear flippers act primarily as stabilizers. This is similar to the turning of a soaring bird, a plane, or an underwater swimmer. If a pinniped wishes to proceed downward or ventrally. turns over, arches the back, spread the flippers, and descends upside dow —a motion similar to the "peeling off of a dive bomber. Ventral flexion i pinnipeds is rare, but does occu particularly at slower speeds when th animals are moving at random an nosing about looking for food.

ALMOST everyone who observes pir nipeds at an aquarium notes tha they spend most of their time swim ming on their backs. One logical ex planation for this behavior might b that since pinnipeds breathe air, i would be of advantage for them t travel at or close to the surface. Yo their eyes are placed on the top of th head, pointing more dorsally tha ventrally. On the surface, upward pointing eyes are of advantage, a they can be used above water wit little of the head exposed. However if a pinniped swam near the surfac but at the same time observed th water below, its best position would b upside down. In fact, harp seals a their breathing holes in the ice poi the nose straight up to breathe, bu look down at the underwater world b bending the necks back, eyes down an chin up. Captive seals breathing on th surface frequently do the same thin

Although pinnipeds are among th best of swimmers, they are not bor that way. Pups are clumsy in the wat and have to toy with swimming f some time before they are able to cat a fish or dive skillfully. The young ma even use their rear flippers ineffectu ally in a surprisingly awkward an scissor-like movement.

I would hope that the future will se more underwater observation of pinn peds, wherein man will learn to appr ciate more fully these and othe aquatic animals as they really are. I the case of pinnipeds, understanding certainly needed, for perhaps no othe group of mammals or marine speci is so little understood or so greatl persecuted, with the possible exceptio of the whales. The advent of skin-div ing has made possible some limite underwater observation of pinnipe in nature. Locomotion in tanks is on thing, but yet to be answered are man questions of how these animals behav when in their natural realm of the sea



LARGELY A BOTTOM FEEDER, walrus has no need for sleekness and speed as do fish- and squid-eating seals and sea lions, but requires power for diving.

NOSTRILS, eyes, and sometimes the ea are above water as gray seal relaxe

Madagascar Lemurs

Insularity permitted their varied development

LEMUR, primarily arboreal, crouches in a tree on the island of Madagascar.

By J. J. PETTER

THE LEMURS, or *Strepsirrhini*, constitute a primitive group of primates that once existed in various places throughout the world. During the Lower Eocene period, small forms of prosimians appeared on a vast block of the boreal continent, which included western Europe and North America. During the Middle Eocene, after the rupture of the land connections between these continents, the prosimians developed independently. Their size increased and the forms became more diversified. At the end of the Upper Eocene they disappeared first from North America and then from Europe, and at present are distributed only in certain parts of Africa, in tropical Asia, and in Madagascar. There is an immense time gap between the fossils of the end of the Eocene and the subfossil remains found in recent projects in Madagascar. No fossil has yet been found in Europe, in Africa, or in Madagascar that would allow us to connect the fossil prosimians with the Madagascar lemurs that exist at the present time.

The present *Strepsirrhini* are usually divided into two suborders: the lorisoids, which inhabit Africa and Asia, and the lemuroids, which live in Madagascar. The group of Madagascar lemurs is characterized by great diversity. Thanks to their early isolation in this territory, these animals were able to develop freely without being subject to the competition that the appearance of the higher primates probably presented on other continents. As a result of these conditions, a great wealth of species and a large variety of forms were able to develop. Many intermediate forms exist, from the *Microcebus murinus*, scarcely larger than a mouse, to the *Indri*, which, with its arms raised, may be as tall as a man.

The lemurs of the genus *Propithecus* are among the most extraordinary of animals. Their coats, which are usually light in color, are their chief

Isolated Primates

Light-colored coat marked with dark areas is a characteristic of lemurs of the genus *Propithecus*. Their behavior gives rise to anthropomorphic legends.

JUMPING LEMUR can cover a distance of more than ten yards. Weak tail is useless during leap and stays relaxed.

identifying characteristic and make them visible from some distance. In the south of Madagascar, where the vegetation is not particularly dense, these large animals are spectacular as the sunlight catches them while they jump through the long, thorny, flexible branches of the *Didierea*. They are primarily arboreal, as are the other lemurs, but their vertical posture, their size—which can reach that of a three-year-old child—and their manner of moving almost exclusively by jumping, set them apart from related species. The ease with which they jump is remarkable. They can actually spring up into the air from any position. It is not rare to see them throw themselves backward and then, while in the air, twist to an upright position before landing.

Lemurs of this genus live in almost all the forests of Madagascar, together with various other genera of lemurs. There are two species—*Propithecus verreauxi*, with white fur that is spotted with black or reddish brown and which lives in the forests of the west and south; and *Propithecus diadema*, which lives in the island's eastern forests and usually has a gray coat washed with yellow and spotted in black. They live in little family groups made up of from three to five individuals.

Unlike several other lemurs, these are unable to locate permanent natural shelters. They are too large to find adequate holes in trees, and they do not make nests of any kind. They spend the night perched on a branch of a tree, and when it is cold they squeeze tightly against one another for warmth. They are active in the day, and their activity, which seems to be related to temperature, occurs primarily in the morning. In summer, they begin to move around before six, while in winter they may not "get up" before seven or eight o'clock. Apparently they particularly enjoy the first rays of the sun.

THEY have a very special stance and means of locomotion. Their bodies are almost constantly vertical, whether they are in repose or about to move. In either case, they are crouched, their tails often rolled up between their thighs, and they are always ready to leap up, activated by a brisk thrust of the hind legs. They usually move by jumping from tree trunk to tree trunk, and these jumps may cover a distance of more than thirty-three feet. During the big jumps, their bodies are horizontal, but when they land, the back paws always touch support first. The tail, which is poorly muscled, is relaxed and completely useless during the jump.

They prefer to eat during specific hours of the day: between eight and ten o'clock in the morning and between two and four in the afternoon. Their diet, although varied, is exclusively vegetable and is made up o buds, young shoots, leaves, bark, an fruits. While the hands are used t draw a branch or a fruit toward them

lemurs do not pluck the food, but take it with the mouth.

They mate from January to March. Gestation lasts about five months, and one young is born between May and August. The newborn is covered with down, its eyes are open, and it knows how to hold to its mother's coat. At first, the young clings transversely across the mother's stomach; at about one month it begins to hold on to her back, a pattern that persists until it is about six months old. They nurse for three to four months, but also begin to eat adult food when they are approximately two months old.

The cries of an individual are chiefly composed of growls and various cooing noises, but sometimes the animals of a group emit a kind of baying in unison. We have heard their cries, for example, at the approach of a bird of prey. One of the lemurs of the group begins and is immediately imitated by the others. Suddenly the cries are synchronized and often can be heard for great distances. The animals also possess a means of olfactory intercommunication. The adult males have a cutaneous gland that runs vertically along the throat. Frequently the animals can be seen smelling trees and then rubbing their throats on the trunks to leave their own particular "trade-mark." It would seem that this behavior is somewhat more frequent during the period of reproduction, but we have observed it at all times of the year.

The family groups usually consist of three or four animals—a male and a female adult and one or two young. Occasionally a group is larger, probably because of the temporary fusion of two smaller groups. When the group leaves its "home," it is generally the female who leads. These groups, however, rarely stray from certain established forest areas, which seem to be determined by the availability of food. Thus, where vegetation is sparse, groups are smaller; where the forest is thick, population density is greater.

The young leaves the parents at about two years of age, at which time it is approaching or has reached sexual maturity. A young male often competes with the dominant male of the community and is chased out of the group if there is a dispute. Several times we have found a young one of about this age completely alone in the forest. It is probable that the young males excluded from the groups eventually join with the young females to found new groups, which are integrated little by little within any group that has suffered losses, although we have not been able to verify this by our observations.

Here a question arises: do these living areas correspond to true territories? If indigenous observers are to be believed, the answer is yes; they say the animals are occasionally given to furious fights, apparently territorial, in which males (and sometimes even females) over two years old emerge with battle scars. There are other indications of limitations beyond which a group does not willingly go. For instance, a pursued animal will suddenly stop as if confronted by an actual barrier, change direction, and turn back in spite of the danger behind him. Nothing visible marks the spot at which he turned. The boundary may be only the space between two trees; a simple jump could clear it. One can sometimes observe different groups on each side of this invisible barrier. The animals look each other over and are ready to chase any intruders who seem to want to cross over. If a member of one group

Unusual agility allows the lemur to take off backward, *above*, then twist in mid-air, to land facing the direction of leap, with rear paws touching first.

clears the boundary, the other group repels it, most often by silent intimidation—a menacing, tense posture, a fixed stare, and a partly open mouth —but sometimes by a few growls.

Lemurs seldom leave their "homes," or territories, which are comparatively small. Some move no more than six hundred yards a day. They usually move slowly and at random while eating, motivated by the warmth of the sun or by ripe fruit on trees. Animals of the same group generally stay together and keep three or four feet apart. Exceptionally, and then only briefly, they come into contact. Unlike other primates, lemurs seldom indulge in reciprocal cleaning sessions, although head- and neck-licking occasionally take place between male and female adults, most often during the period of courtship. Parents also lick the young rather often, and sometimes juveniles lick each other, but this behavior never lasts for long.

UNFORTUNATELY, these charming animals are defenseless against man. The noise of guns does not make them run, even when one of their number is wounded. Their resemblance to man, however, often protects them from hunters. The natives in more primitive regions still respect the ancient shibboleths that prohibited killing them, and when one is found dead it is buried with the same rites that are attendant on human burial. Some people of Madagascar are sure that when a female lemur puts her offspring on her back and faces a hunter who has surprised her, it is solely to protect her young. Others claim that an attacked animal can retrieve a badly aimed stone or arrow and hurl it back at the human adversary. Some even add that when they are hurt, lemurs make poultices of chewed leaves to heal wounds. These are, of course, only legends, but lemur behavior almost forces primitive hunters into anthropomorphic attitudes. They describe the reproachful look that the dying beast fixes on its killer, the jerky arm movements reminiscent of a dying man, and similar analogies.

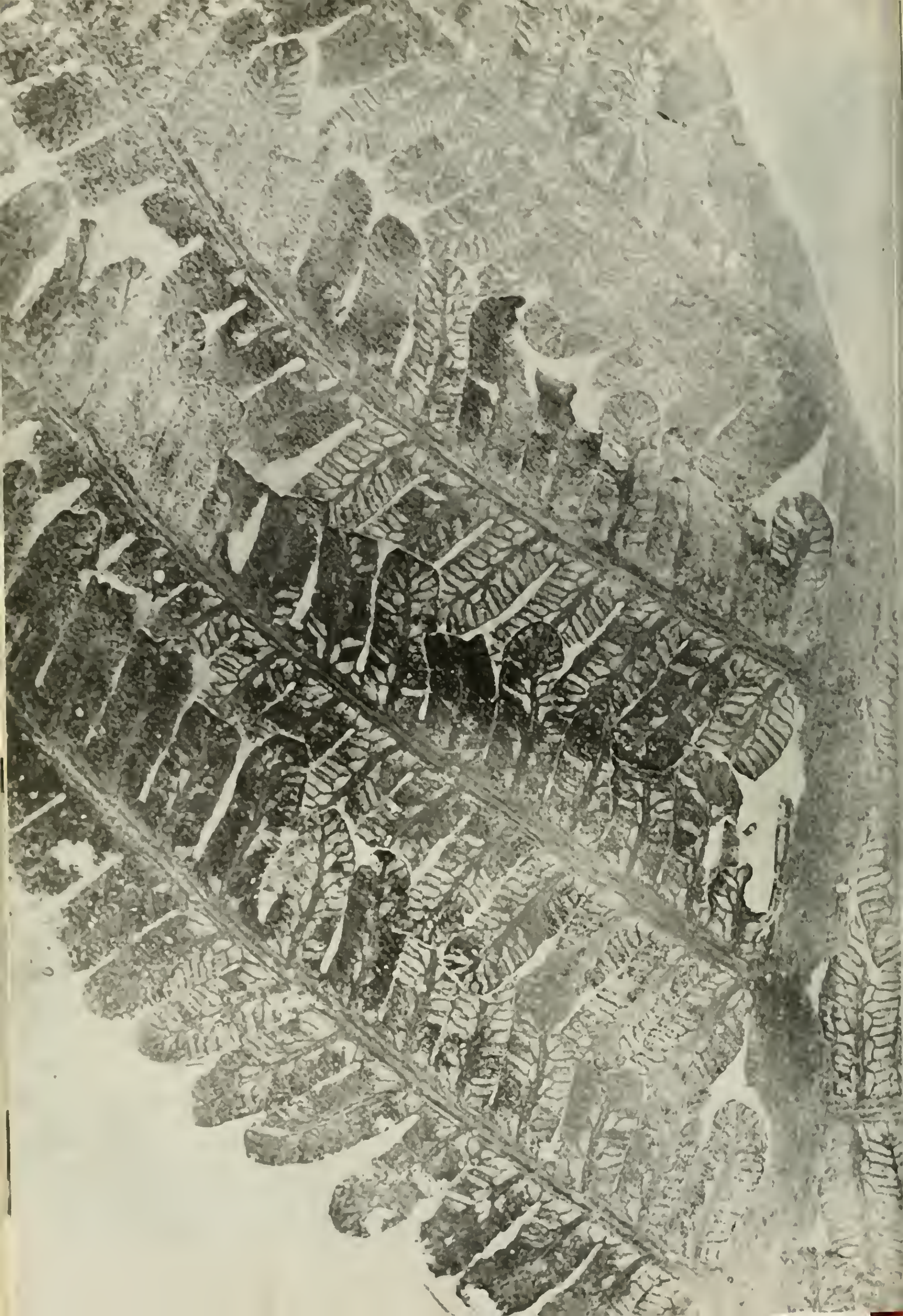
Not only primitive people are sensitive to the death of one of these animals. Few European hunters who have killed a *Propithecus* will repeat the exploit. It is interesting to cite the words of Raymond Decary, a Madagascar administrator: "At the beginning of my stay in Madagascar, it happened that I killed a female . . . in a band that was playing in the middle of some tamarinds. . . . One of these animals crouched motionless on a branch, looking at me. I fired a revolver at it. The animal, pierced through by the bullet, held fast to the branch for a moment with one hand, then tumbled to my feet with a soft noise. It was a mother with her little offspring. The bullet that killed her had struck the thighs of the young one—scarcely larger than a fist—whi she carried on her back and which had not seen. When she fell, the youn which had not suffered from the fa itself, let out groans of lamentatio It went from the body of its moth to me, and in spite of its bleedin wound tried to climb up my leg, the went back to cling to its mother's fu as if to search for one last place protection. . . . Never again, since th moment, have I fired at a lemur."

EVERYONE, however, is not so se sitive. The inhabitants of Mad gascar have been overtaken by civilization that has driven awa many of the old legends. At the sam time, they are in desperate need protein in their diet, and those in th south of the island, especially, ar forced to hunt the animals for foo Nevertheless, it is not hunting th presents the gravest danger to th lemurs. It is by indirection that man eliminating them, by invading the domain. During the last fifty year man's tools and fire have destroye a considerable part of the Madagasca forest. *Propithecus* and the other sp cies, as well as the larger portion the precious fauna of Madagascar, ar located entirely in the forest. If th present rhythm of destruction conti ues, in ten years there will be vi tually no lemurs, and an inheritanc of immense scientific and aestheti interest will have disappeared foreve

TWO-YEAR-OLD young, near or already at sexual maturity, leave the parents.

SPRAWLING with all paws on ground is an atypical position for the lemur.

Nursing lasts three to four months, but young begins adult diet of fruit, leaves, and bark at about two months. However, it stays close to its mother.



Two Fossil Floras of the Negev Desert

Makhtesh Ramon, an Israeli site, yields relics of Jurassic plants

By Jacob Lorch

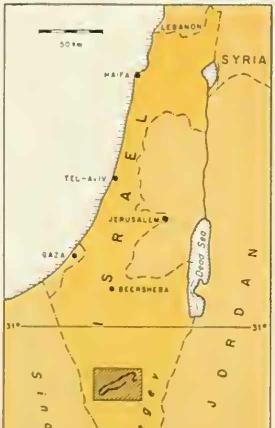
If one looks at the course of the thirty-first parallel north, as it encircles the globe, one cannot fail to notice that a great part of the parallel runs through deserts of the subtropical high-pressure belt. In North America, it skirts Arizona and New Mexico, and in the Old World it cuts through Algeria, Libya, Egypt, and Israel. In Israel, it goes straight across the southern desert, the Negev, which extends over about half the area of the country. For a country as small as Israel, so much desert is really too much desert. But for the paleontologist, a desert may be a veritable storehouse of treasure, and the Negev certainly is just such a storehouse.

Amateur and professional paleontologists who have toured the Negev in recent years have discovered a wealth of fossils—skulls and skeletons of fossil reptiles, frogs, and tortoises, scales of fishes, and imprints of insects' wings, as well as plants—not to mention a variety of marine fossils, which are sometimes extremely abundant. Many more will surely be found, for collecting in a desert is quite different from collecting in more humid regions. When looking for fossil plants in Yorkshire, England, some years ago, we were obliged to travel long distances to reach rock exposures that were not too badly weathered. Elsewhere, the land was covered by soil, and even quarries that relatively recently had yielded good fossil plants had filled up, to turn into swamps or pastures, forever hiding their riches. On one mountain we had to remove a layer of snow to unearth the almost tropical vegetation that had thrived there in the Jurassic period. In the Negev, rocks that have been dug up can

ssil fern imprint shows a fraction sterile leaf of *Phlebopteris branneri.*

Main site of the Jurassic fossil floras found at Makhtesh Ramon, in Negev, is seen from northeast. Dark-colored Cycle Formation slopes to foreground.

First fossils that were excavated at site are examined by the discoverers.



Shaded area on map, in Negev Desert, indicates location of Makhtesh Ramon.

Description of columnar section from base of Triassic to Lower Cretaceous

Period	Description	Thickness
Lower Cretaceous	Sandstone (partly marine)	105.0 m.
Upper Jurassic (?)	Upper Nubian Sandstone (terrestrial)	51.4 m.
Upper Jurassic	Upper Marine Series (marine)	46.4 m.
Upper Jurassic (?)	Main Nubian Sandstone (terrestrial)	320.0 m.
Middle Jurassic (?)	Lower Marine Series (marine)	73.5 m.
Upper Triassic	Gypseous Series (lagoonal)	174.4 m.
Middle Triassic	Dolomite Series (marine)	170.1 m.
Lower Triassic	Sandy Shale Series (marine)	151.5 m.

often be left for years, although what little rain there is will slowly erode the imprints of the plants. The sun eventually causes splitting of the rocks by raising their surface temperature to as high as 170°F., which is then followed by a severe drop in temperature of 60° or more at night.

The abundant sunshine and the scarcity of rain account for the scorched aspect of Makhtesh Ramon, the part of the Negev where I collected two fossil floras. At present, vegetation is very scarce there. An exclusive and highly adapted group of perennials is mainly confined to runnels and wadies, although in spring the rains may call to life an abundance of very short-lived annual plants.

During the Triassic and Jurassic periods various deposits were formed in the Negev, and the clay and sand cover skeletons, shells, and plants in one area or another. In all, there are about 500 m. of Triassic deposits, and a similar thickness of Jurassic rocks. By the Miocene, some forty million years ago, there had formed several major folds, technically known as anticlines. Thus, in the area of Makhtesh Ramon, layers of rock had been warped into a dome. Other tectonic movements of the same period produced the Rift Valley, which includes the Dead Sea—the lowest point on earth—as well as Lake Victoria, in Africa. The movements also seem to have formed the Arava Valley, Israel's eastern border, toward Jordan.

CRACKS produced in the hard layers of rock that formed the roof of the Makhtesh Ramon dome provided the obvious course for new streams that drained the dome's surface. The streams, in turn, began excavating the central part of the dome, cutting their way into deeper and deeper layers. This process of erosion has been unrelentingly active ever since, although rainfall must have varied a great deal. At present it leads to a gradual filling up of the Makhtesh, with rather rare cloudbursts providing the water.

Today, layers ranging from the Triassic to the Upper Cretaceous are exposed in Makhtesh Ramon. A columnar section from the base of the Triassic to the Lower Cretaceous displays general divisions and thicknesses (in meters) that are illustrated in the chart on this page, *above*.

Coming into the Makhtesh from the west, one descends a steep slope of about 400 m. of Lower Cretaceous rocks. Continuing eastward across the wide expanse of the Makhtesh, one successively crosses rock deposits of the Jurassic and, farther east, of the Triassic. The schematic diagram presents both the chronology and the structure of Makhtesh Ramon.

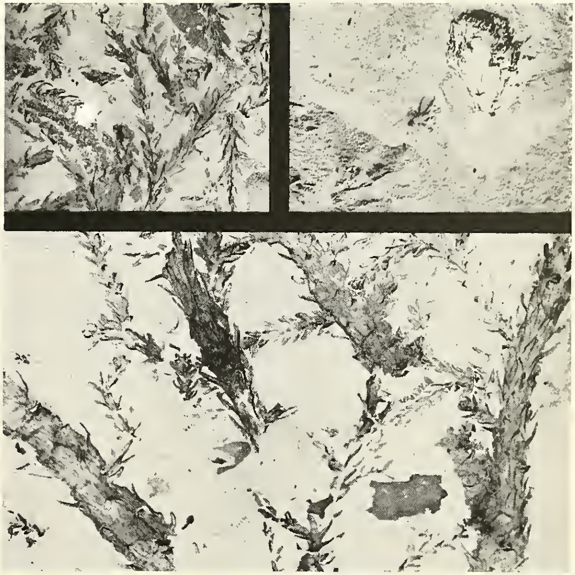
The two floras described below come from the "Lower Marine Series" and from the "Upper Nubian Sandstone," both of the Jurassic. They are separated by strata with a total thickness of more than 300 m. These are sloping strata, and consequently the actual levels at which the two floras occur are only about 100 m. apart, in spite of their differences in age.

Parallel to the western escarpment of Makhtesh Ramon, aerial photographs show several bands of dark brown rock separated by narrow bands of lighter clay or sand. The dark bands are layers of very hard rock, which—by offering increased resistance to erosion—naturally tend to produce coherent platforms, and each cycle of dark rock and light clay represents a cycle of transgression and recession of the sea. The periodic movement of the sea had led to cyclical deposition of sediment, the so-called Cycle Formation.

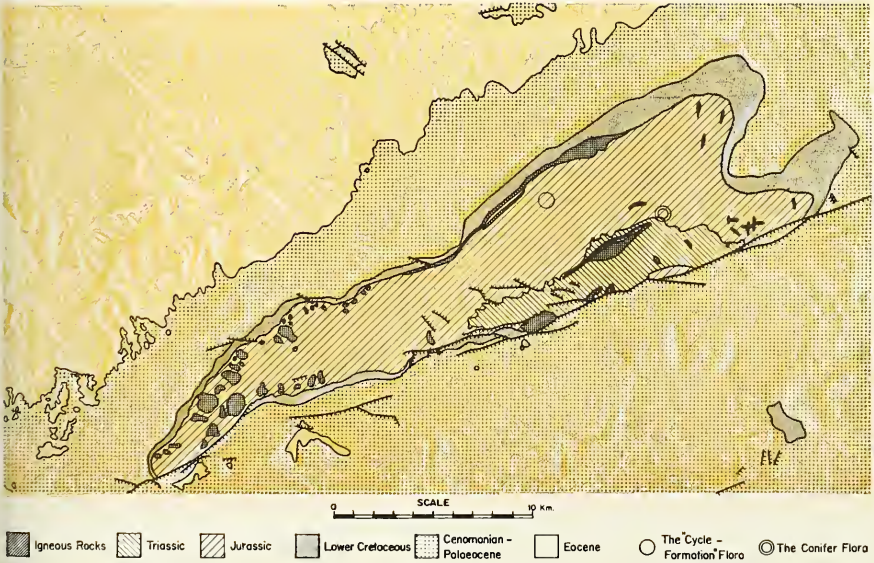
Poorly preserved plant impressions abound on the surface of the brown, sun-baked rock. Only occasionally does one chance upon impressions good enough for proper study. In the spring of 1962 we discovered the first Israeli fossils of *Equisetum*, the horsetail genus. The fossil plants were much larger in diameter than are contemporary representatives of the genus.

THE surface of the Cycle Formation also yielded a variety of leaves. Most of these belong to the Bennettitales, an extinct group of gymnosperms that looked much like the present-day cycads. Their stems, too, have been found in many lands, including the United States. The leaves, variously preserved, are more or less frequent in Jurassic deposits all over the world. They are pinnate, that is, arranged on opposite sides of a common stem, like those of the fossil cycads, and can only be reliably distinguished from cycad leaves by a microscopic study of the stomata, as first shown by Professor R. Florin of Stockholm. In the Cycle Formation no cuticles at all are preserved, and therefore one does not have the opportunity to study the anatomy of the leaves.

Proof that at least some leaves concerned belong to the Bennettitales derives from the discovery of some



IMPRESSIONS of narrow-leafed conifer branches are just above. A male cone (arrow, top left) has microsporophylls on axis. Female cone is at top right.



TOPOGRAPHIC MAP of Makhtesh Ramon illustrates geologic features of the area. Strata of the Cretaceous, Jurassic, and Triassic periods have been uncovered. Circles on the map mark levels at which two Jurassic floras were discovered.

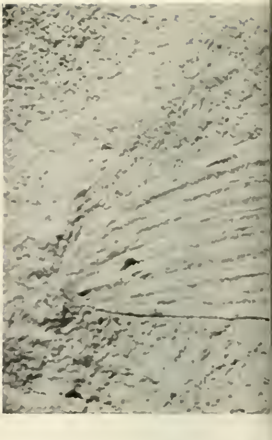
Williamsonia fossils that are heart-shaped and two or three inches long. They are known to have several characteristics in common with the blossoms of recent flowering plants, and some scientists have even suggested that they are the ancestors of the latter. A fossilized closed flower is shown on page 35, top *right*, but more material is needed for analysis of its basic structure. The challenge, of course, is to find out which leaves were borne on any one stem, and which flowers were associated with them.

On the large expanse of the Cycle Formation, an associate who once worked with a bulldozer excavating kaolin for the Israeli ceramics industry discovered an area of no more than four square yards where the plant impressions were more delicate than elsewhere. They had retained just enough carbonized matter to make them stand out, producing lovely black etchings on the red clay in which the plants were embedded.

Assisted by Dr. Herman Becker, of The New York Botanical Garden, I began excavations in the area in 1960. Since then, our little quarry has yielded very valuable material. Because the rock matrix in which the fossils occur consists of extremely hard, fine-grained clay, unusually detailed impressions have been obtained. Thus, in many cases it is possible to ascertain whether the epidermal cells of a plant were smooth or rough. At the same time, the extreme hardness of the rock prevented easy obliteration of the impressions.

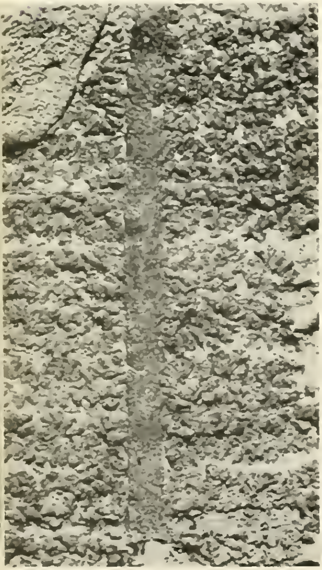
The search for a variety of impressions is but a preliminary stage in the effort to reconstruct entire plants. For example, one species of conifer was represented by hundreds of branchlets, but only one specimen yielded a male cone. This was still attached to a typical branchlet, so there could be no doubt about its affinity. Finally I discovered the impression of two female cones of the same species. A second species of conifer has so far yielded nothing but its branchlets. A single leaf, also illustrated, presumably is a representative of another extinct genus of conifers.

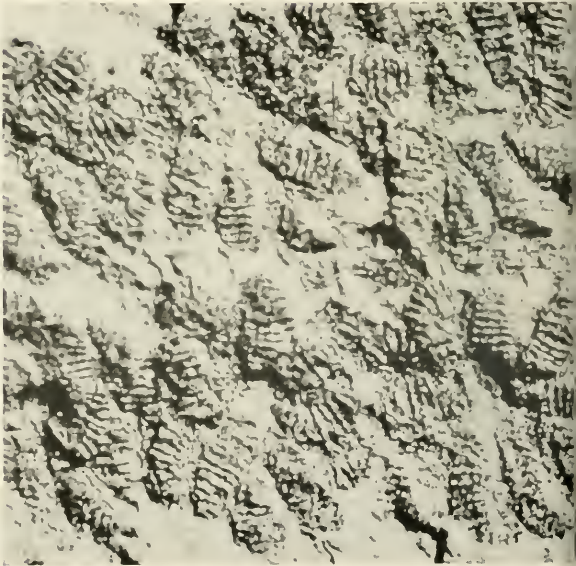
Ferns are the dominant group in the Cycle Formation flora. Their study involves some unique difficulties, which add considerably to their interest.

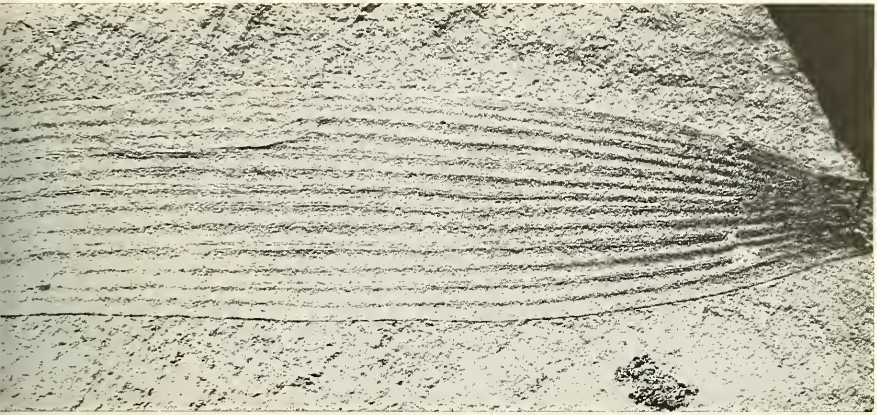


First, ordinary leaves—so-called sterile leaves—may be present to the exclusion of fertile ones, which bear sporangia, the ferns' spore-producing organs. Second, the fertile leaves, although they may closely resemble sterile leaves in shape, are quite different in some groups. If they are found detached from each other, it is

FERTILE LEAF, *below*, of *P. branneri* has two rows of sori on lower side of each leaflet. Star-shaped sori, *right*, are groups of several sporangia (X100).

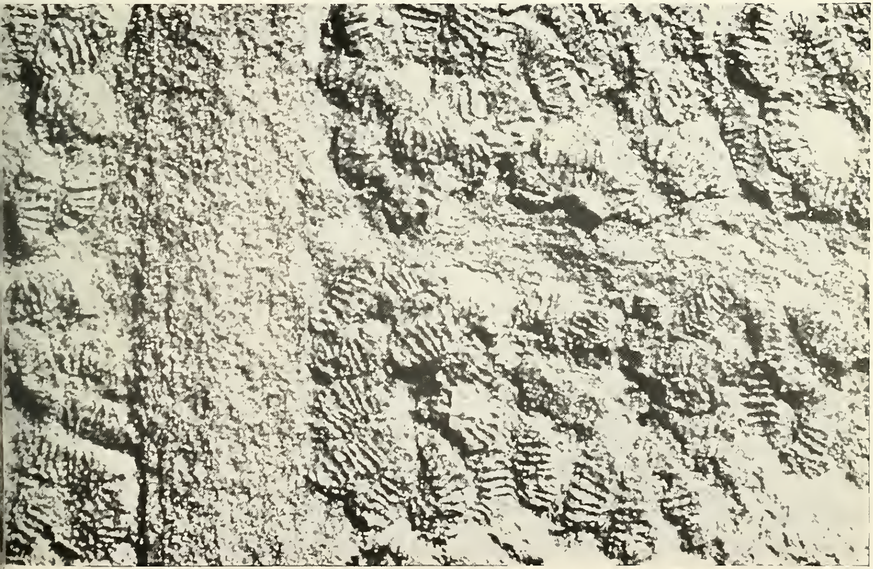


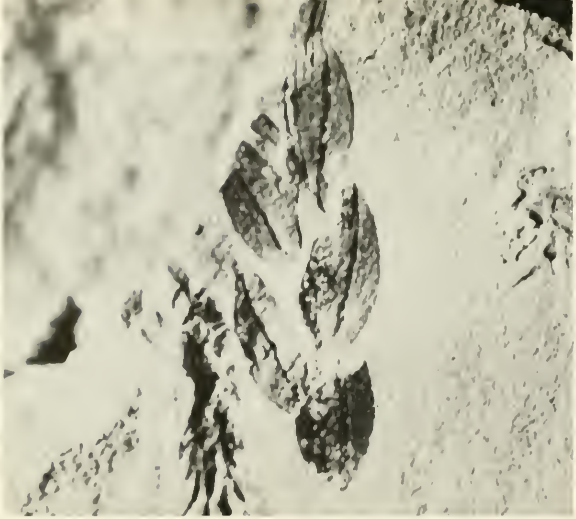




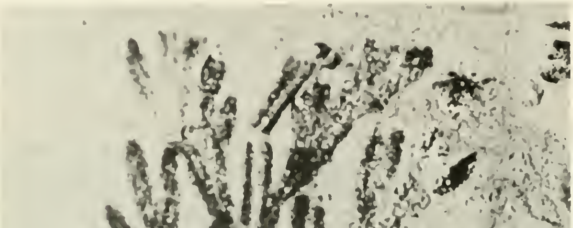
Leaf imprint, probably of deciduous conifer, shows venation very clearly.

very difficult to discover which fertile leaf is related to any given species of sterile ones. Third, fern leaves vary greatly in shape depending on their age. Moreover—as a close look at many recent forms will show—different parts of the same frond may appear quite dissimilar. *Phlebopteris*, seen in several illustrations, is a good example. Among hundreds of impressions of the leaves of *Phlebopteris branneri*, only about a dozen bore sporangia on the lower side. These fertile leaves corresponded in size and shape to the sterile ones. Some had become embedded in the Jurassic clay before they had had time to open and release the spores. The illustrations, *below*, show the impressions of a part of a fertile leaf and of some sporangia. These are arranged in circular groups, or sori, of about a dozen sporangia. The disk-shaped sporangia are arranged radially, and their thick-walled cells (the annuli) show very well. The perfect





SPORE-PRODUCING pinnules of a fern, *Onychiopsis*, are preserved as a fossil, *above*. Discovery at site may be first find of the genus in Jurassic deposits.



STERILE LEAVES of *Onychiopsis* appear different from fertile leaves. Sterile leaflet on a specimen that had fertile organs allowed correlation of fossils.

preservation of the impression made it possible to identify this, the most abundant fern, as a member of the Matoniaceae. A study of the past history of this family is particularly rewarding, for in the Jurassic and the Cretaceous it was widespread, whereas today it is a refugee from climatic change and competition, confined to a rather small area, including parts of Malaya, Borneo, and New Guinea. My fossil species is unique in that its sporangia entirely lack the protective covering that is prevalent in recent members of the Matoniaceae.

I accidentally discovered the second flora (I shall refer to it as the conifer flora) in 1958 while following a rough track that was not marked on maps and seemed to lead nowhere After some miles it ended abruptly at the entrance to what proved to be an experimental tunnel that was being excavated for the mining of flint clay —an exceedingly pure clay that is the raw material for *schamotte*, the fire-resistant tiles used, for example, in bakers' ovens. At the edge of the tip heap was a large, almost black stone At the first stroke of the hammer i broke apart, revealing two surfaces densely covered with small black twigs. None of the many stones I have split open since has yielded as good a crop. Evidently, the flint clay deposits, produced soon after the end of the Triassic (marked in Makhtesh Ramon by gypsum deposits), wer locally covered by a small swamp which gradually filled up with mor clay and with the trunks, branchlets and cones of conifers that grew either nearby or in the swamp itself. When removing the dark gray "conifer" ferrous stones from the roof of the tunnel, I was actually digging down through the swamp with its embedded plant remains.

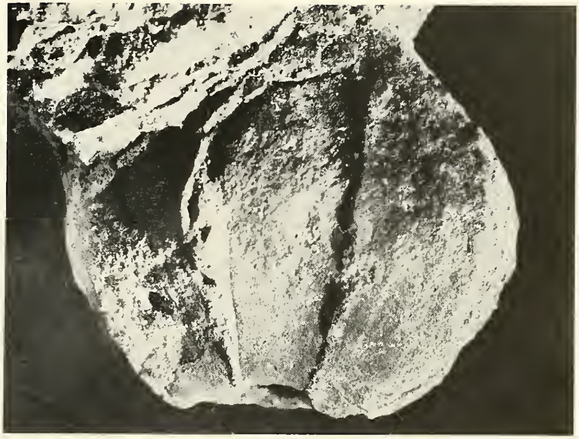
The swamp apparently suffered from poor aeration, for only thus can one explain the sometimes excellent preservation of the cuticles, or plant skins, a variety of cells, and the very delicate pollen grains. A crust o pyrite, or "fool's gold" (FeS), had formed over some cell surfaces, lending them a golden luster. The crust had been there for millions of years, yet a few months in the open air obliterated most of it by accelerated oxidation. An odd collection of bits and pieces was obtained when the chunks of hard clay were split open and whe the soft pieces were slowly washed in a sieve. These pieces included fractions of trunks, up to 20 cm. wide; numerous isolated leaflets; a multitude of small to very small twigs, mostly 1-5 mm. wide; and—most precious of all—complete cones and isolated scales.

As mentioned above, a find itself, no matter how exciting, is only the beginning. Slow and laborious analysis must follow, and work being done on this conifer flora is typical.

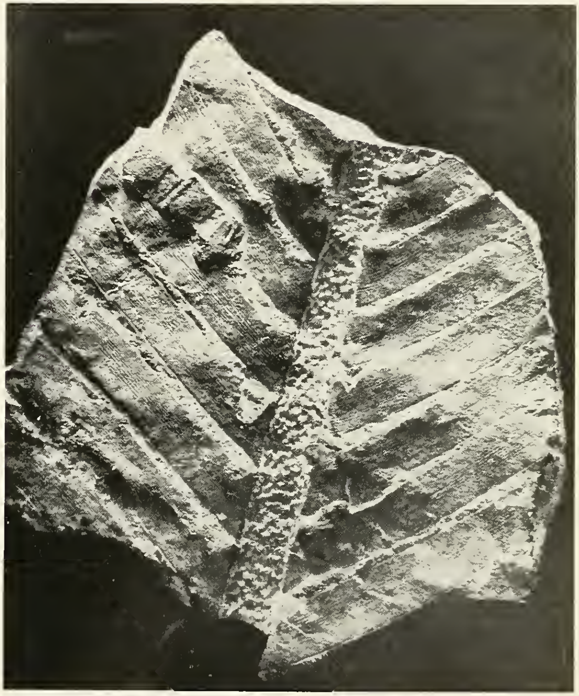
The different species present in the mélange must be identified. With the trunks, this can only be done by observing the anatomy of the woody stem, which consists of tracheids and medullary rays. The characteristics to be noted are the same as those studied by wood anatomists who wish to find out, for example, whether or not a pencil factory has been sold pine instead of the pencil-cedar, *Libocedrus decurrens*. The tracheids are elongate cells with rather heavy walls, which millions of years ago, as now, were responsible for the transport of water in the stems and branches of conifers. Adjacent tracheids are linked by elaborate openings in the cell walls, the so-called bordered pits. The size and density of the pits provide some features for a comparison of different specimens. In fossil as in living forms the pits are confined to the radial walls and may be arranged either in two rows, as in present-day Araucariaceae, r in a single row, as in *Pinus*. The former arrangement is generally considered to be the more primitive, but oth types occur in the conifer flora.

MORE difficult, and more important, is the examination of the medllary, or vascular, rays to discover heir height, uniformity (homogenous s. heterogenous), and, in particular, he nature of the "cross-fields," for wherever a tracheid crosses a medulary ray, there appear areas with charcteristic pitting. Up to twelve pits per ross-field occur in one of my speies; in another only five to six.

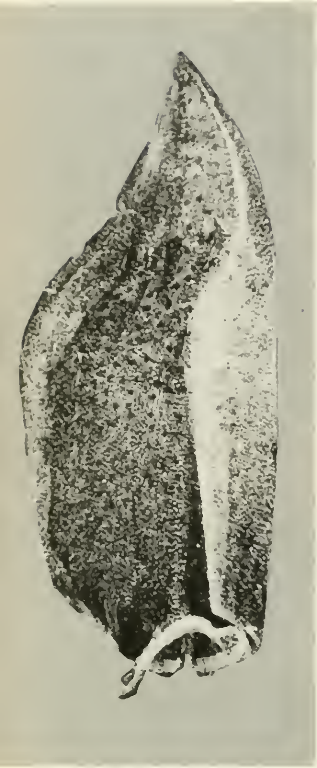
Like the stems, the leafy twigs in he fossils are badly compressed. As ll the species seem to be small-leaved onifers, more or less reminiscent of *huja* or *Cupressus* twigs, rather careul observation is necessary to recogize the various leaves and their rrangement on the stem. Examinaion of gross morphology is complemented by studying the cuticles of the ranchlets, that is, the outer "skin" of



CLOSED FLOWER, *top*, of *Williamsonia* belongs to the Bennettitales, an extinct group of gymnosperms. This fossil was among those found on Cycle Formation.



TUBERCLED MIDRIB of this *Otozamites*, presumably the leaf of another member of the Bennettitales, bears narrow and tapering leaflets at the left and right.



Dark dots are stomata on leaflet of a *Cupressinocladus ramonensis* (X40).

the cells. By clearing and macerating the twigs and carefully opening up the very brittle cuticles, it is possible to obtain microscopic preparations suitable for study by transmitted light. Although the cuticles consist of very resistant carbohydrates, they do not escape the tooth of time as well as one might wish, and often many must be prepared before a really good study cuticle is found. Suitable specimens can then be drawn and photographed, and their thickness, which is highly variable, can be measured. The epidermal cells, which may be smooth or with a more or less prominent papilla, will show up clearly in relatively regular rows, but above all, attention must be paid to what botanists usually call the stomatal apparatus. The stoma proper is an essential plant organ. It consists of two guard cells, which permit, and at the same time regulate, gaseous exchange between the atmosphere and the interior of the plant. The guard cells are frequently lost in fossil cuticles, but the surrounding epidermal cells, which form the stomatal apparatus, tend to be preserved and show extreme differences in structure. They may be thin-walled and located at the level of the leaf surface; they may be sunken and thick-walled, and have prominent papillae projecting over a central pit; or they may exhibit other variations. The numbers of cells comprising the stomatal apparatus also show characteristic differences. Various attempts have been made to relate the structure of the stoma to the natural environment of the particular species.

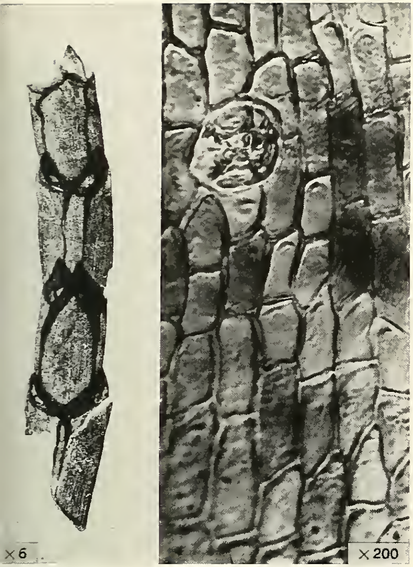
A study of recent plants has shown that species growing in dry environments tend to have stomata in pits that often have elaborate structures—such as hairs, scales, or papillae—which produce a more congenial microclimate in the vicinity of the stomata. On the other hand, plants from humid environments often have stomata at the general level of the plant surface, showing no thickened cell walls, no papillae or other protective structures. Although no absolute reliance can be placed on these interpretations, I think one might reasonably suppose that the stomatal apparatus shown on page 37, *lower right*, represents a species that is much less suited to dry conditions than is the species illustrated to its left.

The next step in the conifer flora analysis was a study of the cones. Again, gross morphology came first, followed by a study of the cuticles that were obtained from the cone scales. There were three distinct species of male cones represented in the conifer flora, some of which yielded pollen grains that proved to resemble each other rather closely. Only isolated scales of female cones were found. Then, as now, conifers had separate male and female cones. So far, I have not found any seeds.

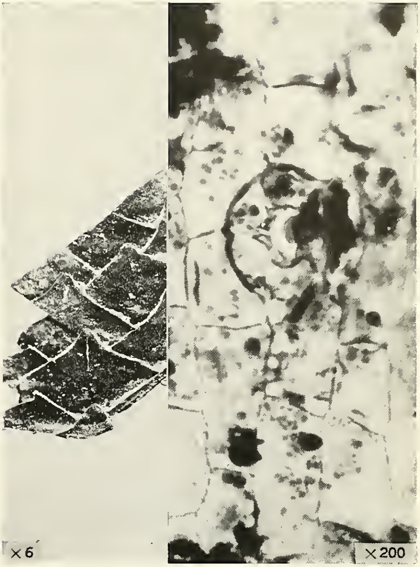
When all is said and done, one is left with an array of trunks from unknown trees, leafy twigs from unknown trunks, and isolated cones, all of unknown affinity. It is at this point that the real challenge begins. Although there is a system of classification for isolated twigs, as well as for cones or trunks stripped of their bark and branches, paleobotanists are above all lured by the prospect of being able to piece together an entire plant of bygone ages, just as Cuvier, in the early years of the last century, reconstructed the first fossil vertebrates. At that time he wrote that he felt "like a man standing in a charnel house, while all around him were fragments of hundreds of skeletons, waiting to be reassembled."

To illustrate such reassembling by means of cuticle analysis, let us take an isolated male cone—the beautifully preserved fragment on page 37, *top right*. The cleared cuticle shows a stomatal apparatus made up of cells flush with the surface of the scale. Each of the four cells looks as if it had been cut off from an ordinary epidermal cell by a curving cell wall, and each bears a large, blunt papilla projecting slightly outward. Next, studying the various species of loose branchlets of the same flora, only one species is found to be at all similar to the cones: it is *Cupressinocladus ramonensis*. However, *Cupressinocladus* consistently has decussate leaflets—that is, the leaflets are in pairs, with each pair at right angles to the one above or below. The cone under investigation has scales arranged spirally. Decussation is a way of life: plants with decussate leaves definitely tend to show a decussate arrangement of their fertile organs, too. Yet there are exceptions, such as the sunflower, which has decussate leaves, but also has flowers set in spirals. In any case, it is reasonable to refrain from ascribing a cone with spiral scales to a species that has branchlets with decussate leaves. To justify a different decision, it should be pointed out that *Cupressinocladus ramonensis* is the species of branchlets that occurs most frequently in the conifer flora, and the cones described are far more abundant than all others taken together. And in paleontology, association of organs is generally accepted as implying an indication of affinity.

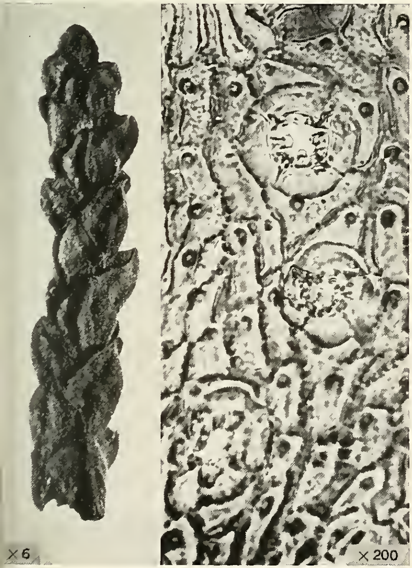
It is almost a truism to say that in science, as in nearly every other aspect of human life, one discovery leads to another. Thus the work that has been done at Makhtesh Ramon may be considered a chapter in a story of the past that will gradually be read in the vastness of the Negev.



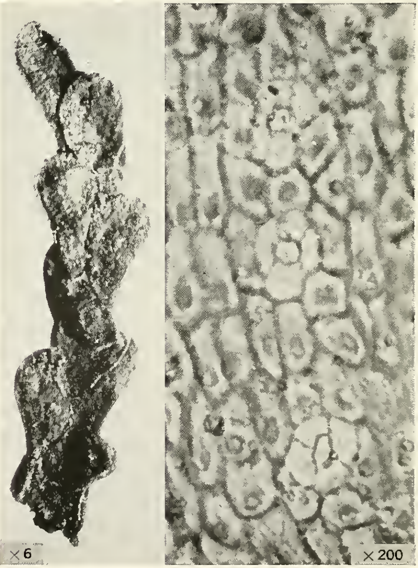
LEARED BRANCHLET of *C. ramonensis* with decussate leaves s at the left. A cuticle with stomata appears at the right.



MALE CONE FRAGMENT, *C. ramonensis*, is at the left. Cuticle with stomata, at right, looks like first cuticle on this page.



UTICLE of *Brachyphyllum*, right, has stomata that seem o indicate adaptation to aridity. A branchlet is at left.



THIN-WALLED CELLS around stomata of *Dactylethrophyllum* may reflect an adaptation to high humidity in undergrowth.

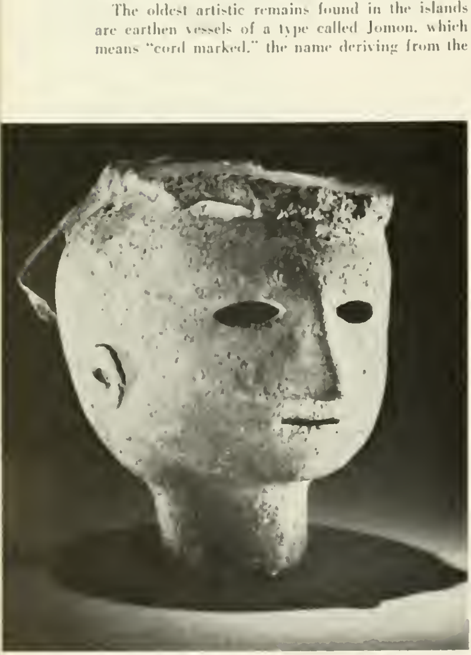
Primitives of Japan
A Legacy in Clay

Sculpture served living and dead in pre-Buddhist period

By Seiroku Noma

Japan is considered throughout the world to have achieved a very high level of aesthetic development, but this reputation is due primarily to arts that evolved after the introduction of Buddhism from the Asiatic continent in the sixth century and which, as a rule, betray the strong influence of continental art. Several thousand years before the arrival of Buddhism, however, the inhabitants of the Japanese islands created an art of clay in which their native sense of beauty was expressed in its purest form.

The oldest artistic remains found in the islands are earthen vessels of a type called Jomon, which means "cord marked," the name deriving from the potters' technique of shaping vessels by pressing on them with wooden clubs wrapped with straw rope. Jomon has given its name to a cultural period subdivided on the basis of families of pottery types into Early, Middle, and Late Jomon.



Delicate head of girl, made during first millennium A.D., is considered to be excellent piece of *haniwa* art.

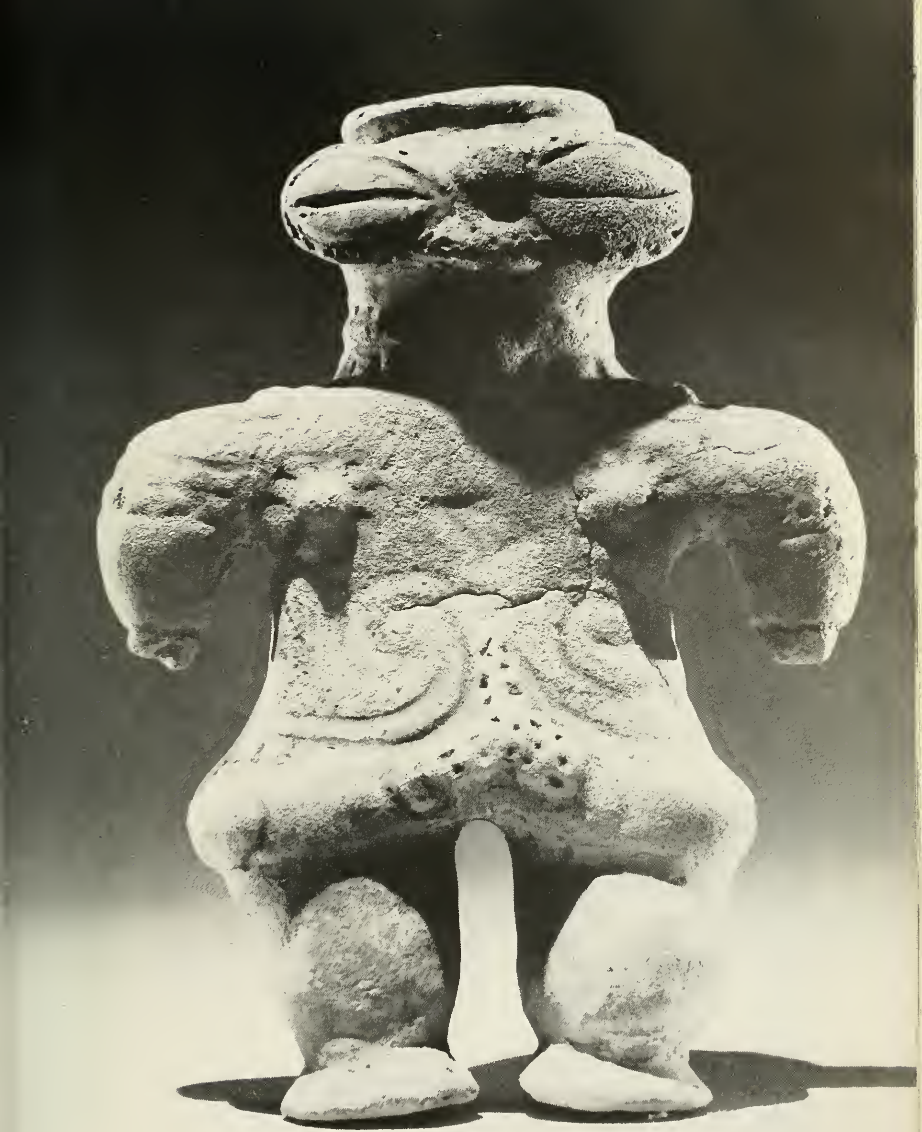
No one knows exactly when human beings first inhabited Japan, but it seems to have been at least ten millenniums ago. Carbon radiation tests indicate that the earliest Jomon pottery dates from about five or six thousand years before Christ. Cord-marked pottery continued to be produced for about six thousand years. The early vessels were simple, with pointed bases and little ornamentation. Those of the Middle period were more complicated in form, with surface decorations that were apt to be more three-dimensional. The pieces from the Late Jomon show the widest variety in shape, but their surface patterns tend once again to become flat. Aesthetically, Jomon ware of the Middle period is the most interesting

The people who made Jomon pottery lived by means of hunting and fishing, and their ware is sometimes decorated with pictures of brave hunters and fishermen in action. All the vessels seem to have been made for actual use in cooking or eating. These early potters clearly possessed a love for and mastery of curved lines, and their inventions are often simila to the abstract art of our own day.

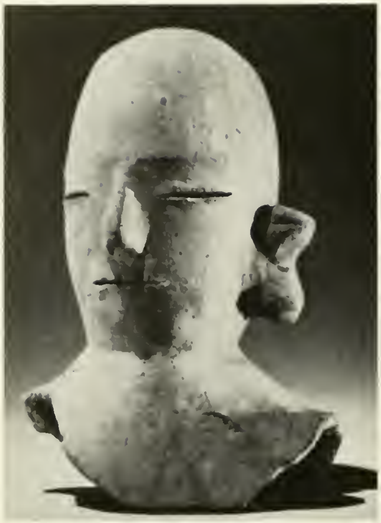
In the Middle Jomon period the experience gained in molding practical utensils gave birth to the even more interesting art of *dogu*—Japan's first rea sculpture. *Dogu*, literally "clay images," were household figurines, and are found mostly in central and northeast Honshu. Since specimens from the forme area are the most original and varied of all, it seems likely that *dogu* originated there. This is hardly surprising when one considers that much of the bes Jomon-type pottery was produced in the same region

No one knows the purpose of the *dogu* or what they represented, but it is not difficult to imagine tha they had some religious meaning. In form they resemble people or animals, but they were most probably intended to represent gods or spirits with superhuman powers. Many of them are similar to the earth goddesses of other primitive peoples.

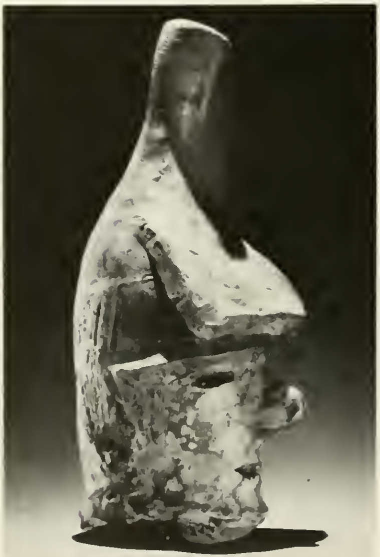
The making of *dogu* spread from central Japan to the east, but in the process the figurines graduall lost in imaginativeness, becoming flatter and les



ROTESQUE FIGURINE is *dogu,* from Japan's Middle omon period, about the third millennium B.C. An image for household use, it may have represented a god. The huge eyes were perhaps to improve vision.



PEBBLY TEXTURE of clay used in modeling head of man is typical of unrefined materials in *haniwa* sculpture.



VISOR AND PLUME HOLDER were parts of metal helmets of Tomb period, a culture *haniwa* has helped explain.

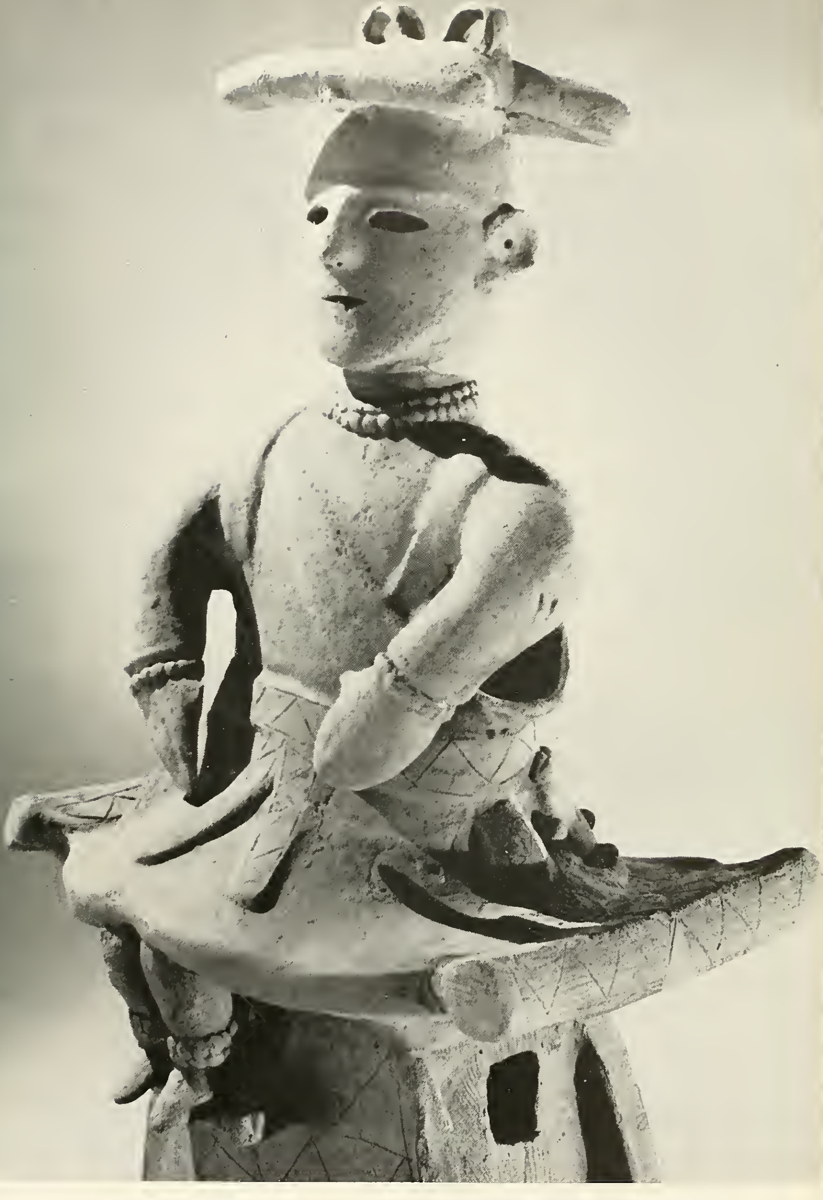
interesting. Farther to the northeast the forms of *dogu* became stereotyped, with large, goggle-like eyes, small arms, and large legs planted wide apart (p. 39). Despite formalization, however, techniques improved. The figures were now mostly hollow, and the curved patterns forming the surface decorations were complex. They show that the same active imagination displayed in the designs on Jomon-type pottery drove the makers of *dogu* to fill every blank space on the figurines in the same way.

With the popularization of *dogu*, the figurines grew simpler. Instead of the whole body, the face alone would be represented (p. 43, right, *top* and *bottom*), and often the figures were reduced to the form of curved patterns inscribed on flat tablets. At the same time, there appeared *dogu* in the form of bears, monkeys, boars, whales, and other animals, but few of these have survived.

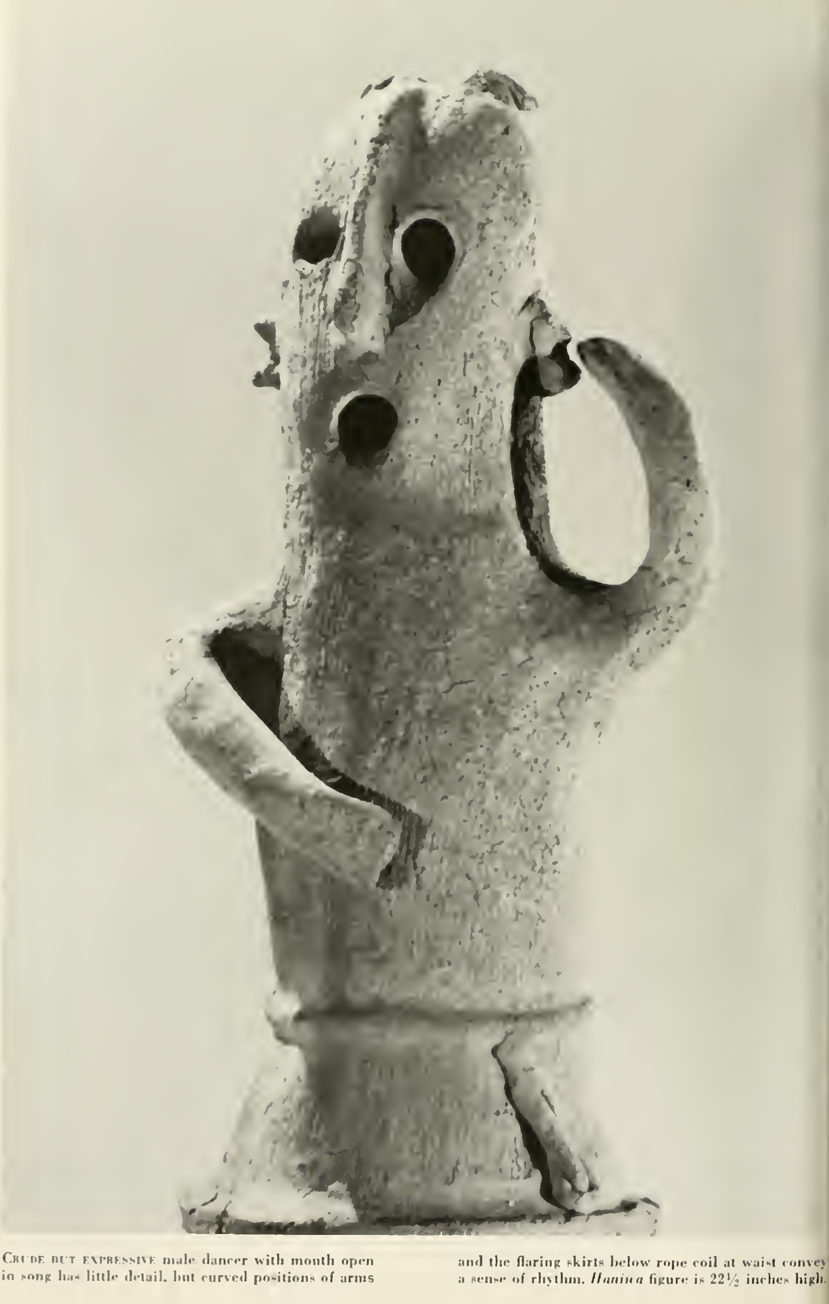
In its late centuries Jomon pottery began to give way to a new ware, smoothed on a wheel and distinguished by much simpler surface patterns and greater clarity of form. This pottery, known as Yayoi after a type site in Tokyo, flourished from roughly the second century B.C. to the third century A.D. The name Yayoi, like Jomon, is a pottery classification that has been applied to a period. Remains of the ware are found mainly in the western half of Japan. This region, which is relatively close to the continent and enjoys a mild climate, turned to wet-paddy rice cultivation at a relatively early date. With the adoption of farming as the chief means of livelihood, men developed the practice of working together in groups to open up new lands and ward off natural disasters. The community life, fixed domiciles, and seasona work in agriculture meant greater social and psychological stability, and this is evident in Yayoi pottery, whose forms became more refined and stereotyped. Vessels grew thinner, and their surface finish took on a new smoothness as the wheel was used more extensively. Although this ware lacks the fancifulness of the old, its regular proportions and curves testify to a high degree of aesthetic sensibility within the farming communities.

Having developed community life, the ancien Japanese began to feel the need for community leaders. There gradually appeared a society in which control was in the hands of powerful families, and by about the third century A.D. this society took on some aspects of a true nation. The leading clans formed the custom of erecting for their dead lords huge burial mounds, or tombs, fitted out to insure the deceased the same ease in death as in life. During the Yayoi period the artistic foundations were laid fo *haniwa*, or "clay cylinders." They appeared in the Tomb period, which began about the first century A.D

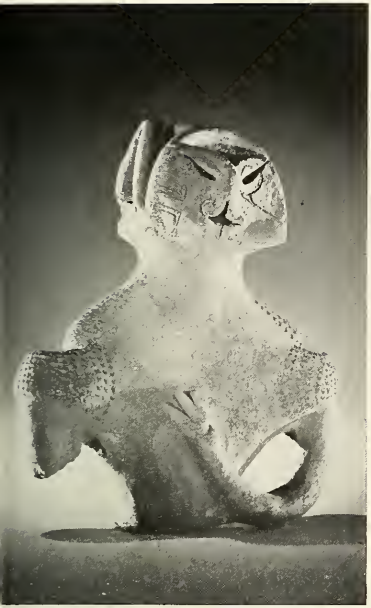
Haniwa were apparently created to be set up on o around these burial mounds, and are, for the mos part, exactly what their name indicates—simple cylinders. A number of them were topped with representational sculpture of a distinctive type. These pieces have captured the attention of modern artists and historians and have given us a wealth of information on the daily life of the Japanese in ancient times



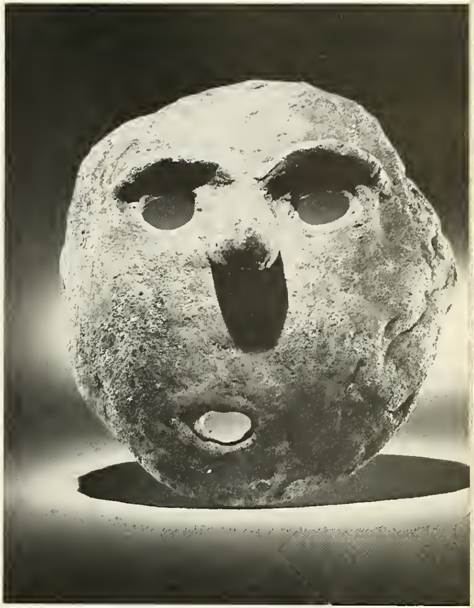
Woman seated on a chair is sophisticated example of *haniwa.* Details of formal dress, hat, beads on the neck, wrists, and ankles, and the small bag and belled mirror hanging from belt may indicate a high social position.



CRUDE BUT EXPRESSIVE male dancer with mouth open in song has little detail, but curved positions of arms and the flaring skirts below rope coil at waist convey a sense of rhythm. *Haniwa* figure is 22½ inches high.



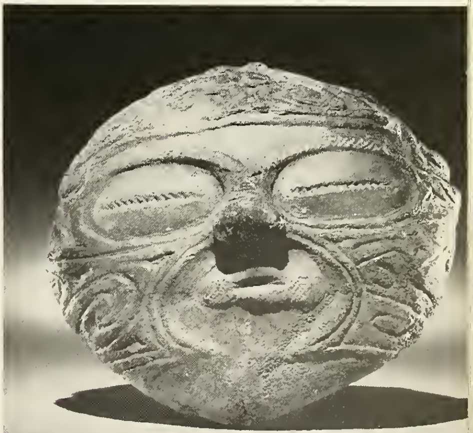
OLID FIGURINE is 10-inch high *dogu.* Features of its
lat face, or mask, are feline and may represent a deity.



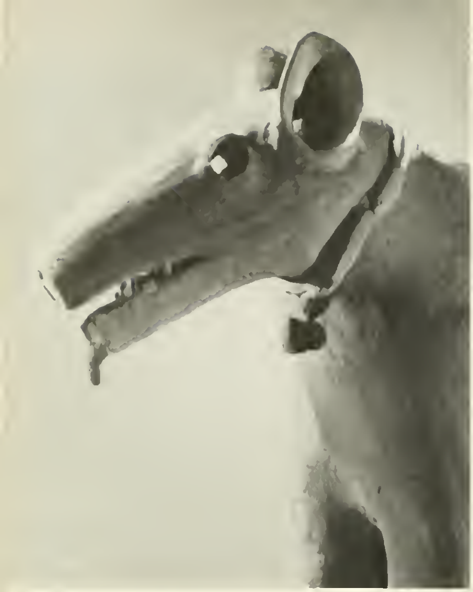
CLAY MASK made in Middle Jomon period is related to *dogu,* and probably had religious significance.

The cylindrical *haniwa,* which are found around
ven the earliest mounds, seem originally to have
een variants on jars containing grave offerings.
hey were set up in fence fashion around the mound,
nd were widely used, it seems, in part because they
elped to prevent the earth on the slopes of the mound
rom slipping. The practice of fashioning earthen
mages of various offerings to the deceased and
ounting them on the cylinders was doubtless a
elatively late development, although the history of
he *haniwa* is still too uncertain to permit attempts
date them precisely.

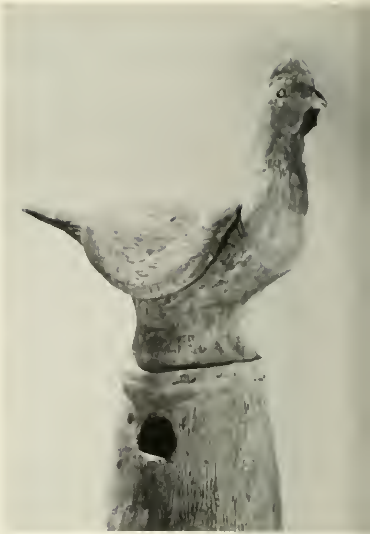
THE process of making these images was simple.
The clay was kneaded into long strands, cut into
ngths, and piled up in spiral coils to form the rough
hape. Then the figures were smoothed by hand and
red. Since the inner surfaces of the statues were not
moothed, the coils of clay are visible. It might have
een easier for the artists to model solid statues, but
ollow ones offered two advantages—they required
ss clay, and they could easily be fired. These fea-
ures no doubt had a special appeal, since it was
sually necessary to make a large number of *haniwa*
n a short time, sometimes hundreds or even thou-
ands for a single mound. The figures were usually
pproximately twenty to thirty-nine inches high, but
n image of a man found in the Tokyo region



OVER-ALL DESIGN and carved eyes in large sockets on a piece from same period show range of technique.



CANINE QUALITY is vividly represented in *haniwa* dog with lolling tongue. Neck bell denotes domestication.



FOWL are among most numerous of *haniwa* animal Deeply punched eyes help give hen lifelike appearanc

measures nearly forty-nine inches—an extraordinary height considering the method employed.

In ancient China there was a similar custom of placing earthen figures inside the tombs of leaders, and stone images of human beings and animals were often erected before the graves. The idea of *haniwa*, then, may have come from China, as did many other elements of Yayoi culture, but the techniques used in making them and the manner of placing them about the tombs were peculiar to Japan.

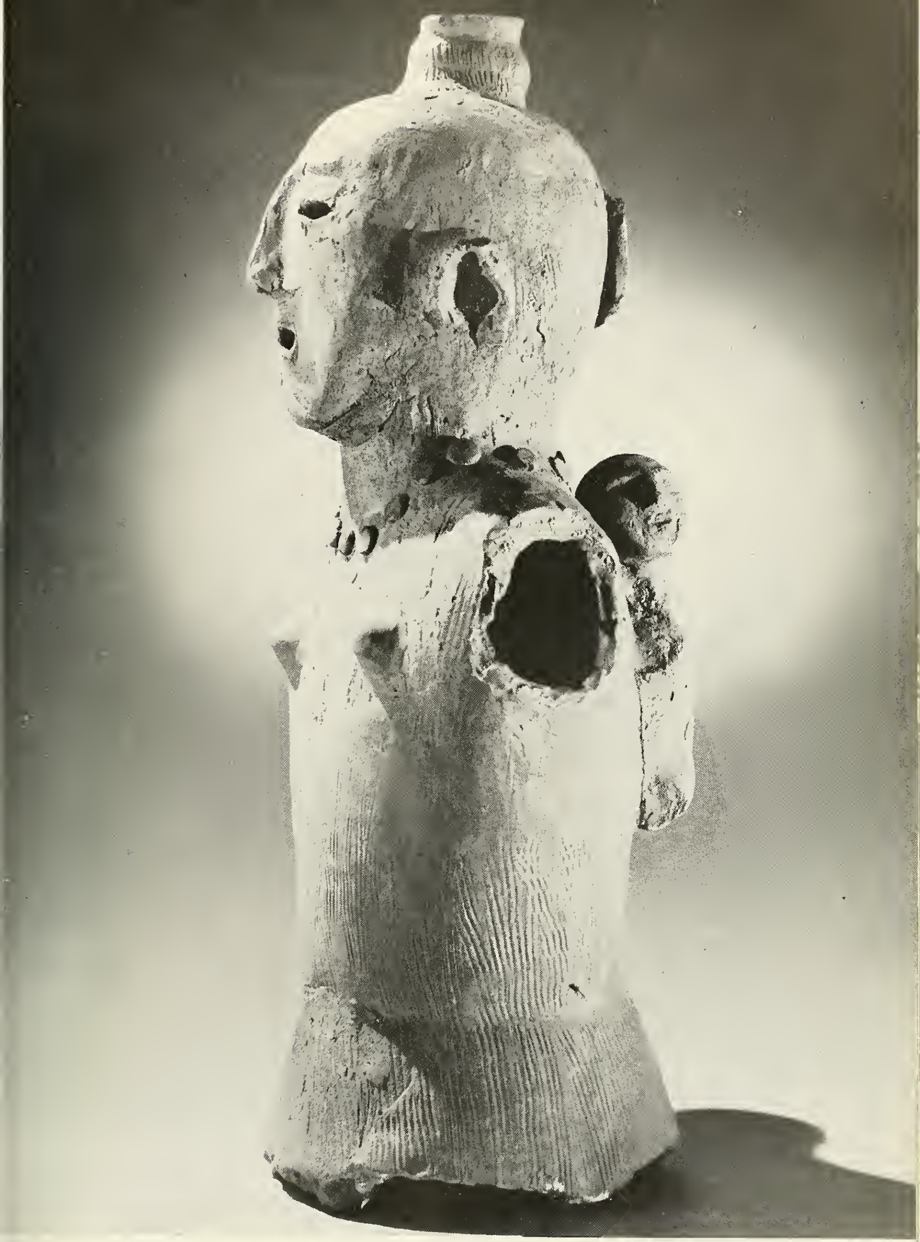
Although *haniwa* were first made in the area around modern Kyoto and Nara, which were centers of contemporary culture, relatively few were produced there, and these display little variety. Moreover, the art appears to have been blotted out by waves of new culture from the continent about the fourth century. To the east, however, in the undeveloped Kanto area (around modern Tokyo), the situation was different. This was a vital frontier area, and warriors of the leading families were sent there from the central district to guard it. Some of these soldiers settled down and became the leaders of the Kanto region. They, too, raised large burial mounds and decked them out with *haniwa*. The local inhabitants, exposed for the first time to the high level of culture the *haniwa* represented, quickly took to the new art. Although the images they produced are not so highly polished as those of the Kyoto district, they are more lively and vigorous (p. 42). There, *haniwa* remained plentiful and varied, and its development continued until the seventh century, when the spread of the Buddhist practice of cremation put an end to a long history of mound burial

Among many *haniwa* forms are those of building which serve as a guide to prehistoric Japanese arch tecture and show how well it has been preserve in Shinto shrines today. Umbrellas and weapons ar also represented. Here again, the idea was doubtles that the deceased would still require after deat those things he had required in life. The most interesting *haniwa* of all, however, are those that portray human beings or animals.

THE human figures include men and women fro all walks of life. Many are warriors carryin swords or shields; some are musicians or dancers some appear to be dignified officials. Some wear bead and finery (p. 11); others are barely clothed. Despit the simplicity of the modeling, a wide range of huma emotions is evident: grief through anger to mirt

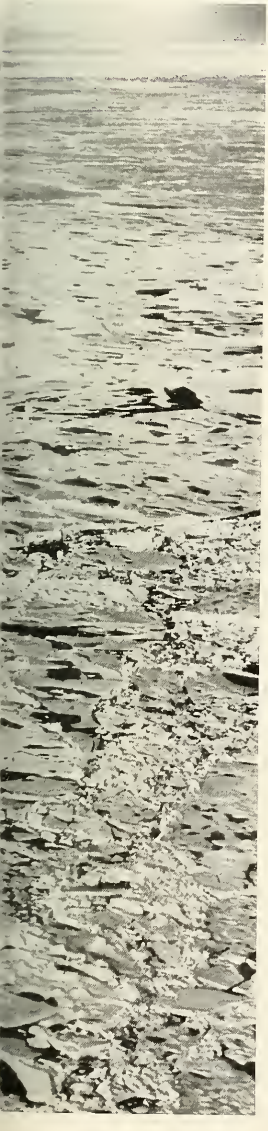
The animal most commonly depicted is the hors no doubt because it was one of the most valuabl possessions a man of this period could have. Othe domesticated animals include dogs and chicken *above*, waterfowl, wild animals, boars, monkeys, o deer. The forms, although ingenuous, catch the essential characteristics of each animal with a keennes of observation remarkable even today.

With the development of Buddhist sculpture, th art of *haniwa* gradually declined and disappeared The race that had made the images remained, however, and the same instinctive sense of form tha *haniwa* reveal appears again and again under different guises through the later history of Japanese art



Mother with baby on her back may have been depicted going about daily chores, symbolized by jar on head, indicating she is not of a high social position. Vertical striations are common on *haniwa.*

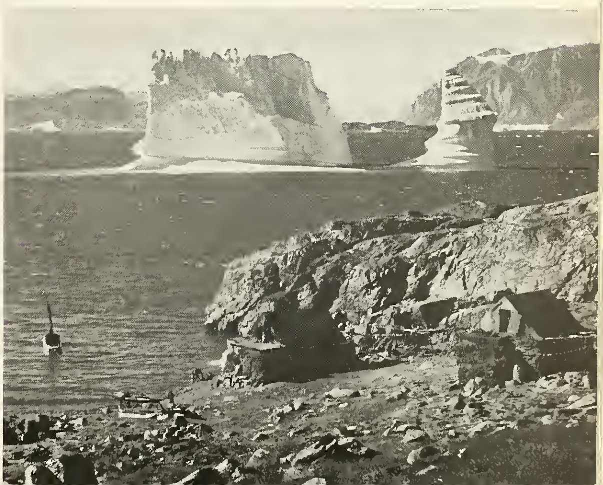
Land of Silence, Fascination and Beauty



Dr. Lauge Koch, in his preface to *Arctic Riviera,* which is Swiss photographer Ernst Hofer's tribute to a land of contrasts, says: "Whoever has once experienced the Arctic, will never cease to be overcome with nostalgia for the midnight sun, the unspoilt beauty of this remote world, in spite of the hardships and austerity that are inseparable from a stay in Greenland." The book includes geologist Koch's notes on expeditions that he has led to the great island, is a product of the Swiss geographical publishers, Kümmerly and Frey, of Berne, and is distributed in this country by Rand McNally. The pictures and text on these pages have all been excerpted from the unusual and beautiful volume, which deals specifically with the fjord country of northeast Greenland.

Conditions change so rapidly that even the most experienced captain may find his ship to be icebound off the East Greenland coast.

A last primitive place of human habitation, the settlement of South Cape consists of only a few wooden huts surrounded by turf brick.



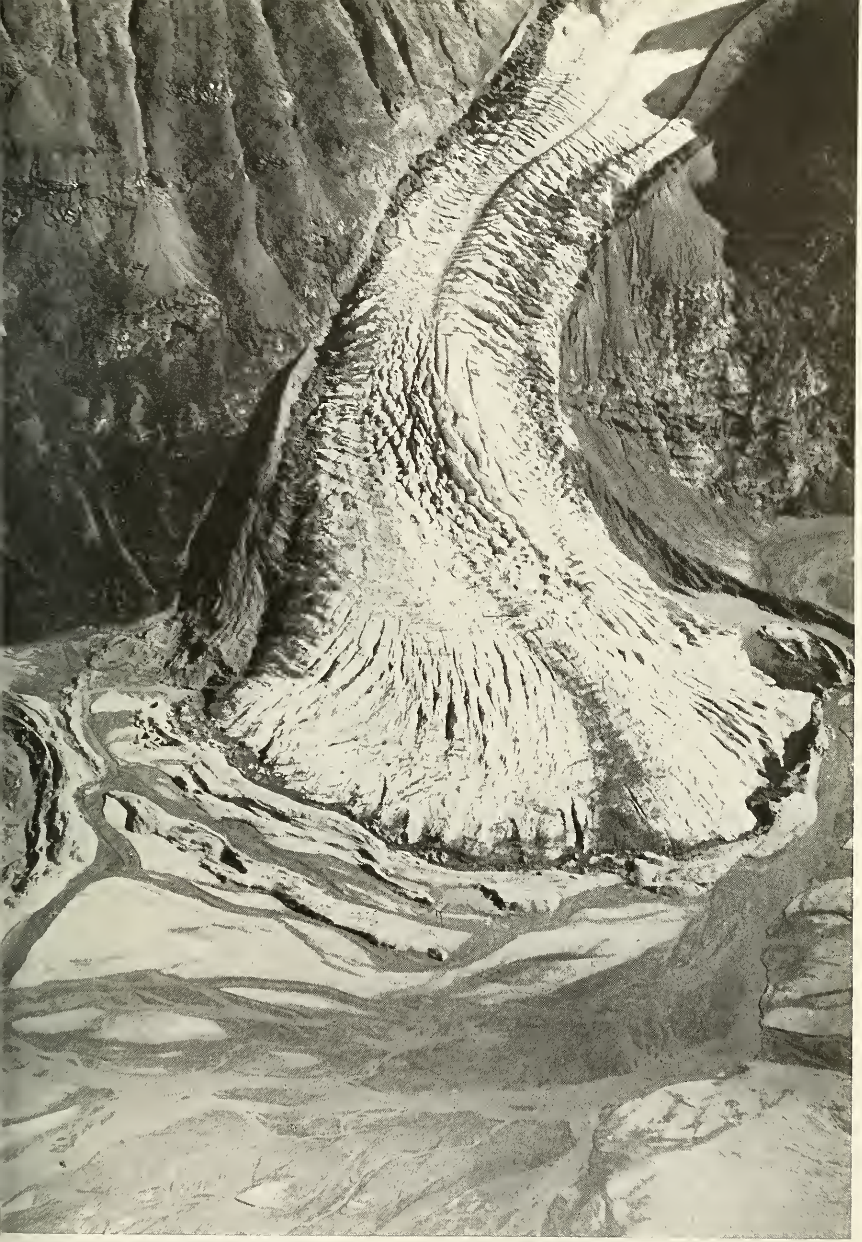
Nunataks is the name given to the isolated peaks that rise above the icecap. Average mean temperature in this cold country is about −18° Fahrenheit.

Groups of pseudovolcanoes are formed when ground water attempts to penetrate the permafrost, then freezes and heaves the earth above it into mounds.

The outer coast of Greenland was first visited about 130 years ago by English expeditions. Fifty years later Germans spent the winter in East Greenland and brought back the first accounts of snow, ice, and climatic conditions of that season. In 1926 a new epoch of exploration began, and it continues to this day under Danish auspices. East Greenland, betwee Danmarks Fjord in the north and Kangerdlugsuak in the south, forms a geosyncline, or narrow trough, which has filled with deposits in the course of long geological ages, and contains large quantities of animal and plant fossils. In various places there are lowland regions, otherwise rare in Greenland, and there are also three areas with rugged mountains—some are over 9,000 feet high—making the region topographically interesting.

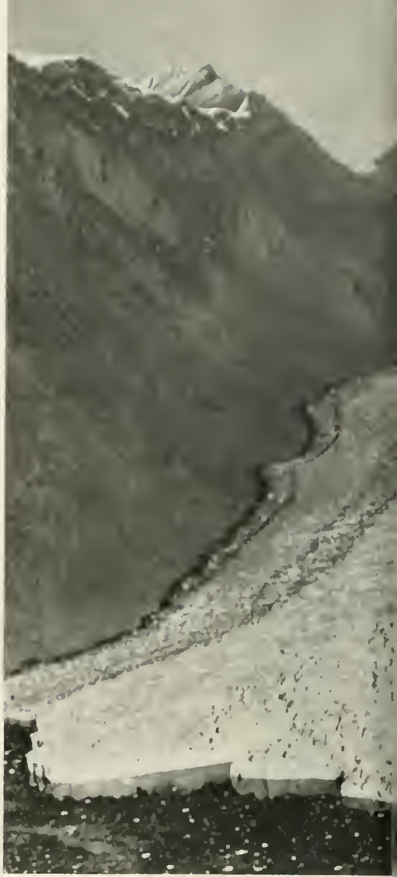
Between two of the largest glacier streams in eastern Greenland rises a grim massif of bewilderingly complex structure on which no man has yet set foot.

Looking weirdly like the feet of some prehistori
reptile, these glacier tongues creep toward the valle



e photograph of the still-unnamed ice sheets
s taken over the innermost section of Rhedin Fjord.

In winter, the ice in the fjords extends from the interior branches to the outer coast. In the region of Ella Island, in Kong Oscars Fjord, it forms from November onward and, until the beginning of May, is a compact, continuous expanse of ice. The ice first begins to thaw in the branches of the fjords. Thawing advances steadily toward the coast, so that it is possible for a plane to land between the tenth and the fifteenth of July. Occasionally, the ice remains like a broad barrier right across the mouth of the fjords. When this remaining "bolt" of ice melts depends on the weather in May and June, which in turn is determined by the breadth of the belt of drift ice. A narrow band of such ice permits moist Atlantic air to shield the land from the sun, and melting is delayed, sometimes until the first week in August. Summer and winter alike, a constant ocean stream carries large masses of the drift ice from the Polar Basin southward along the east coast of Greenland.



Terminal face of this glacier is almost three miles in breadth. As the ice masses are steadily pushed toward open water they break off and form icebergs.

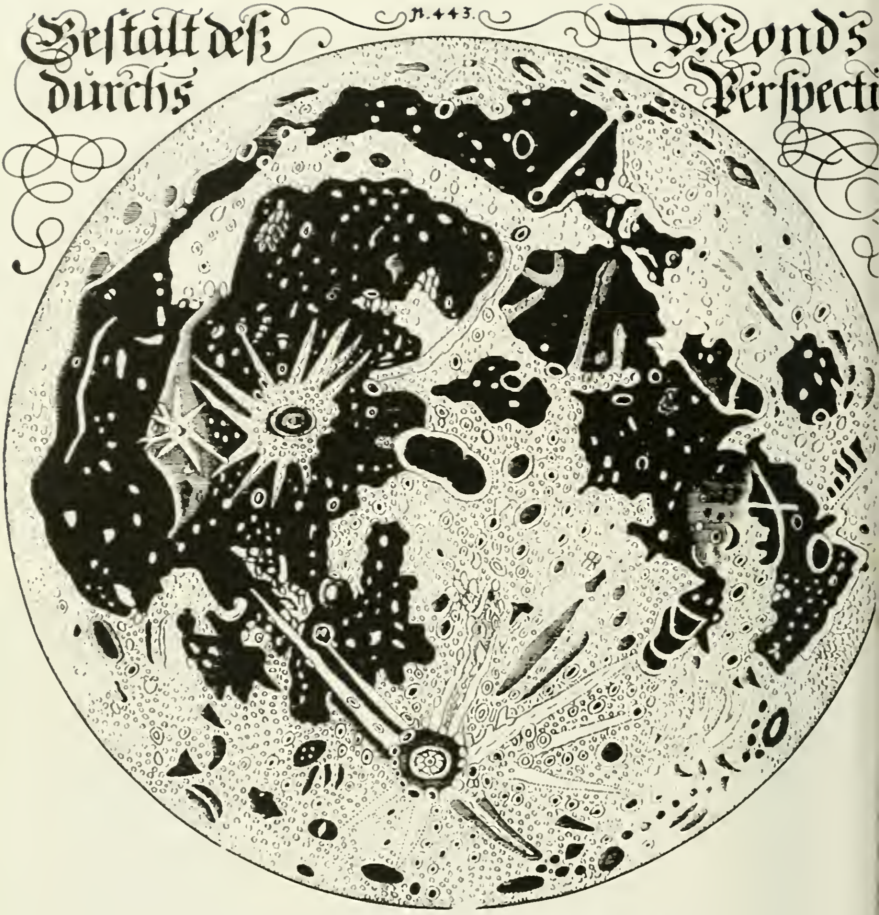
Abstract design is the maze of the Schuchert River watercourses, whose islands of drifting sand continually shift toward the fjord and change patterns constantly.

Canyon-like valley has been cut deep in this fjord, which has been sounded at a depth of about 3,000 feet. The great icebergs come from miles inland.

The ice belt off one section of East Greenland probably attains an average breadth of nearly 190 miles. It may be densely or loosely packed, and its character may often change. In the later part of the year, the ice floes are six to ten feet thick on an average, and in spring they may be several miles long, but in the course of the summer their size decreases steadily. In the belt of drift ice one is usually able to navigate safely, as the ice masses ordinarily move, even in a severe storm, in the direction of the wind.

Summer warmth carves and molds the ice into fantastic forms that often fall apart within a few days. For only a brief time can Eskimos use their kayaks.

The moon rises over the iceberg-strewn water. Now the period of the midnight sun is drawing to a cl
and the long, long polar night is fast approaching.



SKY REPORTER

Waxing or waning, the moon has always interested ma

By Simone Daro Gossner

THE STARTLING OBSERVATIONS made with early telescopes caused as much interest in the universe in the seventeenth century as the first launchings of man-made satellites a few years ago. Popular descriptions were written to satisfy the curiosity of educated laymen. Illustrations were copied from the observers' scholarly accounts and, depending on the engraver's skill, readers could get a more or less accurate idea of the latest discoveries. A favorite item was Hevelius' telescopic map of the moon (1647 It is shown, *above*, as it appeared in a German compendiu that was published in 1676.

The theories of Copernicus had demoted the moon fro the rank of planet to that of mere satellite, or companio of the earth. Galileo's telescopic discovery of the first fo satellites of Jupiter reduced the moon's status further showing that it is not the only object of its kind in the sol

On these pages MRS. GOSSNER presents the third in her 1963 series—a co-ordinated review of the solar system.

stem. However, the moon still boasts one unique distinc-
on: it is the largest satellite relative to the parent planet.
r this reason, modern astronomers often call the earth-
on system a double planet.

Popular interest in the moon has never faded entirely
ce Galileo made his first crude sketches. This is doubt-
s one of the reasons why the public was readily taken in
the historical moon hoax perpetrated by *The New York*
n in August, 1835. Pretending to quote from a non-
istent scientific journal, the paper published fantastic
counts of lunar discoveries by Sir John Herschel, who
s then at the Cape of Good Hope. By using an enormous
escope and a new observing technique, the articles said,
rschel had achieved tremendous magnification. Lunar
habitants, odd-shaped animals, and temples studded with
ecious gems were revealed in minute detail. A sensation
New York, the story was soon carried by the foreign
ess and the hoax became general. When truth prevailed
ew weeks later, it was discovered that the author (R. A.
cke, editor of the newspaper) had merely intended at
st to ridicule the sensational popular writers of his day.
s readers' gullibility had turned the matter into a hoax.

IRLESS, waterless, rocky, and barren, the moon cannot
sustain life. Astronomers have little doubt that it has
permanent atmosphere because during its crescent
ases there is no halo of twilight along the dark edge;
dows cast by its mountains are sharp and black, not
rred by air scattering as shadows are on earth; and
en the moon passes in front of a star, the latter dis-
pears abruptly, without the progressive fading that would
cur if a transparent gas were to move past first. It has
n suggested recently that the moon may have a transient
nosphere of helium and argon. But it would be so
nous that, in comparison, the air we breathe would be
million million times as dense. The helium and argon
uld be the products of radioactive decay of rocks on the
ar surface. The moon's low surface gravity—only one-
th that of the earth—would be insufficient to retain these
ses permanently. If they are present at all, they must
ntinually escape into space while new gas atoms are re-
sed from the rocks.

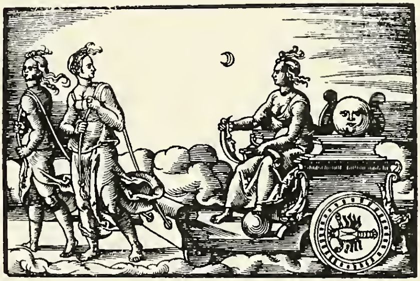
In the absence of an atmosphere, and hence of weather-
, there is very little erosion on the moon. Its surface
rs the permanent scars of events that took place billions
years ago, side by side with recent features. The entire
ar history could be reconstructed if only these markings
ld be interpreted correctly. At present, astronomers can
w some general conclusions, but they must wait until
ual samples of surface materials are obtained before a
finite theory can be advanced.

Through a powerful telescope, the moon's face appears
ted by innumerable craters, one next to the other, often
erlapping, and decreasing in size to the limit of visibility.
me large plains, misnamed *maria* (Latin for "seas") by
rly selenographers, have the appearance of lava flows,
t are probably "oceans" of dust. Most remarkable of all
the mountain chains, which, for lack of erosion, have
mained strikingly jagged. Judging from the length of
ir shadows, many are nearly as high as the tallest moun-
ns that are found on the earth.

The origin of lunar craters is as yet an unresolved problem. Their superficial resemblance to extinct volcanoes suggests a possible volcanic origin. However, it is not certain whether or not the moon was ever in a molten state. Some internal heat could be generated by radioactive elements in its core, but it is unlikely that this could account for the multitude of known craters. A few years ago, observers in Russia and England noted traces of residual volcanic activity in the form of gas escaping in the vicinity of a crater. Thus the volcanic theory should not be considered entirely unacceptable.

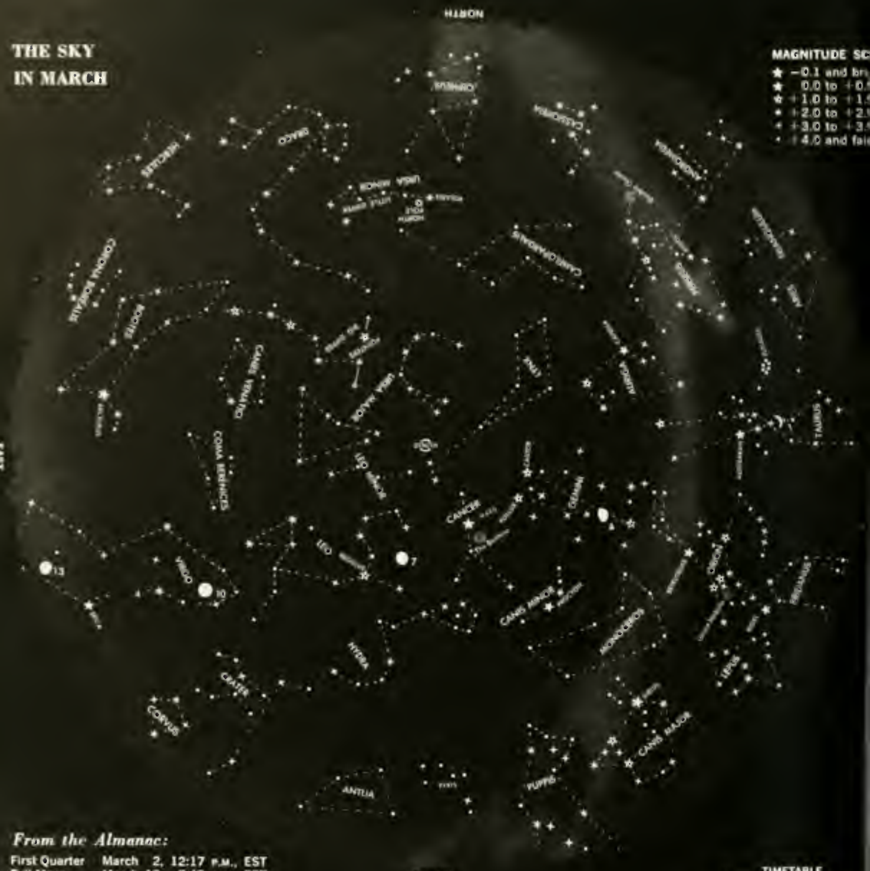
A more promising theory, which probably does explain the majority of the craters, attributes their origin to meteoric impacts. A strong argument in favor of this theory is the overlapping of many of the craters. One might wonder why such features are so numerous on the moon, whereas they are relatively scarce on the earth. It must be remembered, however, that continuous erosion would have obliterated all but the most recent terrestrial craters. In addition, the heat generated by the braking effect of the earth's atmosphere consumes the small meteorites and often disrupts the larger ones in mid-air. Meteorites or fragments thereof reach the ground at appreciably reduced speed, thus lessening the impact. On the moon, conditions are the exact opposite. Since there is no atmosphere, all approaching meteorites reach the surface intact and at full speed, and, without erosion, the collision scars are preserved forever.

Only 59 per cent of the lunar surface has been mapped in detail, although crude pictures of the moon's far side were obtained by Lunik III. The moon's rotation period is exactly equal to the period of its revolution around the earth. Consequently, it always keeps the same face turned toward us. We are able to see somewhat more than half of its surface from terrestrial observatories because of the effect called *libration*. The moon's axis of rotation is tilted to the plane of its orbit and since it always remains parallel to itself, we alternately see slightly beyond the moon's north and south poles. This oscillation is the *libration in latitude*. Additionally, although both rotation and revolution are completed in the same time, the rotation occurs at constant speed, whereas the speed of revolution varies according to Kepler's law of areas. Accordingly, the rotation alternately lags and gains during the revolution, thereby allowing us occasional glimpses of the east and west sides of the moon's disk. This is called the *libration in longitude*.



MYTHOLOGICAL REPRESENTATION of moon, published in 1569 in Cologne, is taken from *Poeticon Astronomicon* of Aratus.

THE SKY IN MARCH


NORTH
MAGNITUDE SC
★ −0.1 and bri
★ 0.0 to +0.
✩ +1.0 to +1.
• +2.0 to +2.
• +3.0 to +3.
• +4.0 and fai
CEPHEUS
CASSIOPEIA
DRACO
HERCULES
URSA MINOR
POLARIS
NORTH POLE
CAMELOPARDALIS
ANDROMEDA
PERSEUS
CORONA BOREALIS
BOOTES
ARCTURUS
CANES VENATICI
URSA MAJOR
BIG DIPPER
LYNX
AURIGA
CAPELLA
TAURUS
ALDEBARAN
COMA BERENICES
LEO MINOR
EAST
CANCER
GEMINI
CASTOR
POLLUX
The Beehive
VIRGO
SPICA
13
10
7
LEO
REGULUS
CANIS MINOR
PROCYON
ORION
BETELGEUSE
RIGEL
ERIDANUS
MONOCEROS
HYDRA
CRATER
CORVUS
LEPUS
SIRIUS
CANIS MAJOR
PUPPIS
ANTLIA
PYXIS
SOUTH

From the Almanac:

First Quarter	March 2,	12:17 P.M., EST
Full Moon	March 10,	2:49 A.M., EST
Last Quarter	March 18,	7:08 A.M., EST
New Moon	March 25,	7:10 A.M., EST
First Quarter	March 31,	10:15 P.M., EST

TIMETABLE

March 1	11:00 P.M
March 15	10:00 P.M
March 31	9:00 P.M

(Local Standard Time)

For the visual observer:

Mercury, in the morning sky, will be suitably located for observation only during the first few days of the month. On March 1 it will rise one hour before the sun and may be seen low in the southeastern sky before sunrise. By March 15 it will rise only thirty minutes before the sun. In superior conjunction on March 30, it will enter the evening sky.

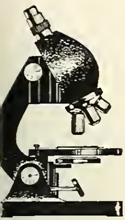
Venus (—3.6 magnitude) will rise in the morning sky roughly two hours before the sun throughout the month and will be found low above the southeastern horizon at sunrise. On March 20 it will be about one degree north of Saturn.

Mars, which reached its nearest approach to earth last month, is now receding rapidly. Its distance from us at the end of March will be ninety million miles—nearly as great as the earth's distance from the sun. Concurrently, Mars' apparent brightness will fade from —0.5 magnitude March 1 to +0.2 March 31. Mars will be high in the eastern sky at dusk March 1, setting in the northwest about an hour before sunrise. By March 15 and for the rest of the month, it will be nearly overhead after sunset, setting ninety minutes before sunrise March 15 and two hours before on March 31.

Jupiter, in Pisces (—1.6 magnitude), will be in conjunctio with the sun on March 16. It will thus be lost in sunlight excep for a few days at the beginning and at the end of the mont The planet will set about an hour after the sun on March It will enter the morning sky after conjunction and will ri forty-five minutes before the sun on March 31.

Saturn, in Capricornus (+1.0 magnitude), will be in th morning sky. It will rise in the east about an hour before th sun on March 1, ninety minutes before on March 15, and tw hours before on March 31.

The vernal equinox will occur on March 21 at 3:20 A.M EST, marking the start of spring in the Northern Hemispher On clear, dark nights, observers situated far from the ha of city lights may have a chance to see the zodiacal ligh After their eyes have become accustomed to the darknes they should inspect their western horizon immediately aft evening twilight. The zodiacal light is a faint glow about bright as the Milky Way. It is broadest at the horizon a stretches along the zodiac, becoming narrower as the angul distance from the horizon increases. It is sunlight reflect by dust particles scattered throughout the solar syste



NATURE and the MICROSCOPE

Study slide preparation

By JULIAN D. CORRINGTON

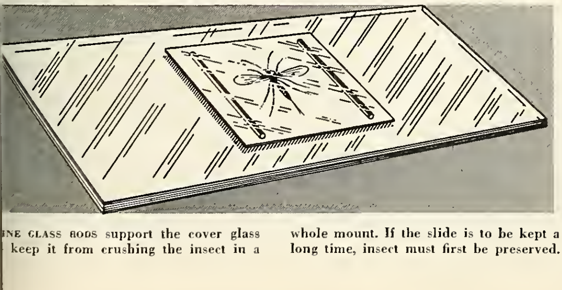
THE COMPOUND MICROSCOPE is a wonderful instrument that makes pos- ble the study of cells and tissues in rmal cytology and histology as well as cells in abnormal conditions resulting om disease. It also permits analysis of ystal structure in chemicals, rocks, inerals and metals, and the determina- on of product purity in foods and drugs, smetics and condiments, paints and rnishes, leather, rubber, paper, and xtiles. The industrial microscopist in- ects milk for bacteria, canned toma- es for molds, steel bars for content and oper amalgamation of such additives carbon, chromium, or nickel, and mples of wool for adulterants. The ientific crime detective scans finger- ints, counterfeit money, spurious sig- tures, bullet scratches, and bloodstains. e microscope is truly the king of in- ruments. Yet by itself it is merely a eans to an end. Observation is what unts, and obviously the operator must ve something to observe. This "some- ing" is known in microscopy as the ject, regardless of its nature.

In general, there are two classes of jects: the whole object prepared with- t sectioning, as indicated by the old rm "*in toto* mount," now usually called whole mount, and sections, made by icing the whole into thin segments. aterial destined for microscopic exam- ation is normally mounted on micro- ope slides, which are usually thin ass rectangles, three inches by one. he glass is special quality, free from riations or air bubbles. The edges are ound to prevent cutting the operator's gers when the slide is handled, the surfaces are polished, and the slides are packed in regulation boxes containing half a gross. Sales of boxes of blank slides are in the millions annually and each supply house features its own brand.

At times observations of animals, such as hydra, are made while the living specimens are in water in watch glasses. One can examine ring settings of gemstones, luminescent numerals on the face of a wrist watch, firing pin marks on cartridge cases, or textiles, paper money, engravings, photographs, or maps without mounting the objects on slides. But most studies are made with slides.

AFTER the object is processed it is capped with a cover glass. This is a very thin sheet of fine quality glass, obtainable in several thicknesses (0, 1, and 2, with 0 the thinnest); in three shapes (circles, squares, rectangles); and in numerous sizes, with dimensions given either in fractions of an inch or millimeters. Cover glasses are sold in boxes in half-ounce units.

Whole mounts must be processed with regard to the type of illumination that will be used. Most slide preparations are designed for study by transmitted light – the illumination coming from below, directed up through the object by the substage mirror, and thence through the optical system of the instrument to the eye of the observer. Obviously, such objects must be thin and either transparent or translucent, like insect wings, postage stamps, or smears of bacteria. Light rays coming through the object are refracted or diffracted by the fine detail and are focused by the optical



NE GLASS RODS support the cover glass keep it from crushing the insect in a whole mount. If the slide is to be kept a long time, insect must first be preserved.

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You, your school, your organization can help make a dream come true for Cecilia, or some other Indian girl or boy. Just a $10 monthly contribution provides one Indian child with suitable clothing, personal books and a cash allowance for school activities. It is an act of love that will bring you a heart-warming reward. A photograph, the story and letters from the child you help will start off a warm person-to-person relationship. Please give one Indian youngster an even break — and the sense of belonging to the wider world around him.

SCF

Save The Children Federation, Norwalk, Connecticut

I wish to contribute $120.00 annually to help an American Indian girl ☐ boy ☐ Enclosed is my first payment:

$10.00 a month ☐ $ 60.00 semi-annually ☐
$30.00 a quarter ☐ $120.00 annually ☐

I cannot sponsor a child. Enclosed is contribution of $_____

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Contributions are income tax deductible. NH-3-3

elements of the microscope to form an enlarged image of the original. When we look through the eyepiece we never see the real object but rather an optical illusion—an enlarged replica, which is implied by the term "image."

The other method of illumination is called incident light, the source of which is a lamp above the stage. Light rays pass downward to the object and are then reflected back up through the tube to the eye. This method is used to examine such opaque objects as die castings, coins, most entire insects, small skulls, and seeds. Objects too dark or thick to transmit light are studied this way.

Size is a limiting factor for slide mounts. Certainly an entire large beetle is unsuitable for microscopic examination, except to scan some superficial features by incident light. A large organ, such as the human brain, is not ordinarily studied this way, although specialists have prepared huge sections of entire brains and mounted them on very large glass slides. More often, thin sections of small parts of the brain are mounted on regulation slides, and the brain is studied piecemeal.

Whole mounts are of two main classes. The first includes all objects that are visible macroscopically—embryos, parasites, small insects or other invertebrates, small crystals, and fingerprints. These are whole mounts in the usual sense of the term. The other class is that known as smears, which comprise entire microscopic objects of an organic nature. This category includes smears of blood, sperm cells, bacteria, protozoa, algae, pollen grains, and soils.

Sections may be cut in any of three planes when the specimen is a bilateral animal or a multicellular plant. Take the case of a small fish, for example. A longitudinal section through the entire fish, bisecting it into right and left halves —that is, a median longitudinal section in the plane of bilaterality—is a sagittal section; if to one side of the median plane, it is a parasagittal section. The cut may be longitudinal, but parallel to the dorsal and ventral surfaces, thus dividing the animal into back and belly portions. This is a frontal, or horizontal, section. The commonest cut is the transverse, or cross section, which runs across the body at right angles to each of the preceding sections described.

In a tree stem, which has radial symmetry, there may be cross sections and two sorts of longitudinal sections. One is parallel to a tangent to the stem and is called a tangential section; the other is along a radius and is a radial section. With any of the multicellular organisms, a section perpendicular to the surface is a vertical section. On microscope slide labels, the sections are commonly abbreviated by their initials: c.s., l.s., or v.s., for example.

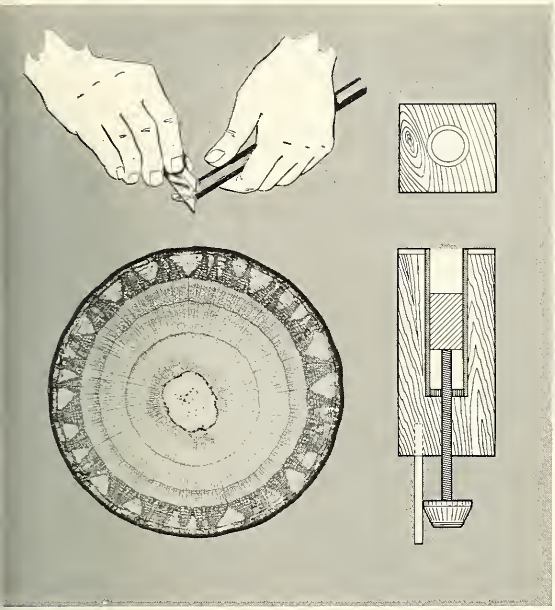
Sections may be cut freehand, an old-fashioned razor or a sa razor blade in a holder. Such sections rarely true or of uniform thickness is difficult to avoid cutting wedge to obtain sections that are thin eno for study. For precise work a machin employed. This is the microtome, wh may be hand-operated and simple, automatic and fairly complex. simple ones are well microtomes, which the material to be cut is embed in a well or cavity, such as the hol of a tube. At the bottom of the wel a screw, which, when turned, elev the floor and pushes the object upw. After each turn a section is cut wit razor and removed for mounting; screw is turned again and another tion is cut. This insures uniformly flat sections.

There are several types of mac microtome. One, the freezing microto can be connected to a pressure tank carbon dioxide. When the operator leases a jet of gas from the tank, it fre the object and embedding medi around it, permitting fast process Freezing microtomes are used in ho tals, where a quick tissue diagnosis be vital. Others are the sliding mi tome, in which the knife travels alo trough; the rocking microtome, in wh the tissue block rocks up and d across the knife edge; and the ro microtome, which has a wheel cr. turned by the operator, that actuat mechanism that advances the tissue u the knife with each rotation. All of th cut very thin, uniform sections.

Just as smears form a special cate of whole mounts, so grinding meth comprise a special class of sections. S hard objects as bone, teeth, hard se fossils, rocks, minerals, and metals not be cut with a razor. Therefore thin a section as possible is cut wit hack saw and then ground down abrasives, such as carborundum wh and emery paper, until it will tran light and is the desired thickness.

With any object a series of step required to prepare it for examina and, if the object is perishable, for manent preservation. The steps, plus the intricacies of sectioning, consti the important adjunct science of mi technique. One may examine fresh terial, but to prepare a slide that last long, sequences are necessary.

Microtechnical procedure is foun on a number of generalizations. Firs is a substitution program. The organ or tissue is originally infiltrated water, for example, but later steps for the complete elimination of wa which would otherwise cause the orga material to rot. So something else n be substituted for the water. Second order to effect such changes, one m learn about miscibility—a term that



:EHAND SECTION of a plant stem is cut h razor blade, at top left. Transverse tion of basswood stem is illustrated in the photomicrograph. A homemade well microtome, in top and cutaway side views, is used for cutting uniformly thick sections.

lly means "mixability"—of reagents. e microscopist must be aware that ter and alcohol are miscible, but that ter and xylene are not, whereas pure ohol and xylene may be mixed. Thus, go from water to xylene, it is first :essary to pass through alcohol in a ›stitution series. Replacing water with re alcohol sets up violent diffusion curts, since the two compounds mix too idly; pure alcohol has a very strong :mical affinity for water. Consequently, s customary to go through a graded ies of alcohol strengths to make the nsition less abrupt.

n the classical agenda, material is sed from water through 35, 50, 70, 95. and 100 per cent strengths of ohol, and thence into xylene. This is led "going up the alcohol ladder." At er times it is essential to hydrate the ue and reverse this procedure, to "go vn the alcohol ladder." In college and ustrial laboratories ethyl (grain) ohol may be used. but strict govern- nt regulations prevent private in- iduals from obtaining it easily. The ding substitute for ethyl alcohol is iso- pyl alcohol. obtainable without re- iction since it is not potable. The anhy- us grade, 100 per cent, is preferred.

The stages of microtechnique for whole mounts of such subjects as hydra or planaria include killing, fixing, washing, staining, washing, dehydrating, clearing, and mounting. With sections, after step three (the primary washing) come dehydrating, clearing, infiltration, embedding, and sectioning. This is followed by spreading the sections on slides and deparaffinizing them, hydrating, primary staining, washing or destaining, dehydrating, counterstaining, washing, completing dehydration. clearing, and mounting. The procedure is complicated, and calculated to imbue the owner of a finished slide with respect for all the time and effort that had to be invested in its preparation.

An example or two will serve to clarify these generalities. Let us suppose the operator wishes to obtain finished slides of a cross section of basswood stem—a very widely used slide type in general botany. A young, green stem is selected and a half-inch piece cut from it with a sharp knife or razor. This is placed in a fixer. a chemical compound that will kill the living cells of the stem and preserve them against post-mortem changes. This takes care of two steps at once—killing and fixing. There are many form-

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ulas for fixing agents, and every technician has his favorites, but among those most widely employed is F.A.A., a mixture of formalin, acetic acid, and alcohol. The stem segment is placed in about one hundred times its own volume of F.A.A., and left in it overnight or longer, since the time duration in this fixer is unimportant. The segment is then transferred to 50A (50 per cent alcohol, or half water and half pure alcohol), and subsequently to 70A, 82A, 95A, and 100A. It remains about half an hour in each. These substitution steps remove all water in the cells of the stem by replacing each water molecule with one of alcohol.

Now a half-and-half mixture of absolute alcohol (100 per cent) and xylene is used, followed by two changes, for thirty minutes each, in pure xylene. Xylene (xylol is the German equivalent) is a colorless, oily hydrocarbon, a coal tar derivative, and it is used in this instance because it is miscible with both pure alcohol and paraffin. The stem piece is now placed in a mixture of half-and-half xylene and melted paraffin, then into three paraffin baths in succession, in a low-temperature oven, to embed the material in pure paraffin without traces of the xylene; thirty minutes are needed in each of the first two paraffin baths, but the third may be longer. The process is infiltering. The last step is embedding.

A low-melting-point paraffin is required, and the commercial product obtainable from gasoline companies is commonly used, although a more recent supply house product, called Tissuemat, is now popular. The cooled paraffin block containing the segment of basswood stem is trimmed and mounted on the carrying block of the microtome, and sections are cranked off at any desired thickness—ten or twenty microns, for example (a micron is .001 mm.). Clean slides are albuminized and sections cut from the paraffin ribbon, as it comes off the knife, are floated on water on the slides. Gentle heat evaporates the water, and the paraffin sections are drawn down into the thin smear of albumin affixative on the slides until they adhere firmly. The slides are now allowed to dry thoroughly. This is called "spreading the sections," since they expand and flatten while drying, eliminating wrinkles.

The paraffin is dissolved off with xylene and each section slide is run down the alcohol ladder to water, thirty seconds per step, then placed in safranin, a red dye that will stain the xylem of the vascular bundles (see NATURAL HISTORY, October, 1962). The sections should be purposely overstained, from overnight to twenty-four hours. Washing must be speedy when safranin is used, as it is rapidly extracted. The slides are dipped in water and then in each of the ascending series of alcohols for half a minute or less, until they are in 95A, when th
are counterstained with fast green F
for thirty seconds. This stains the phlo
and remaining tissues. Now the slide
passed rapidly through fresh 95A
wash the green, then through 100A, t
changes of xylene, and then is mount
in balsam or a commercial synthe
neutral mountant, such as Permou
The slide is kept flat until dry, then it
cleaned, labeled, and stored or used.

A section of a cat's intestine would
similarly processed, but zoologi
prefer different reagents. One of th
favorite fixers is Bouin's fluid, a mixtu
of picric acid, acetic acid, and formali
This material cannot overfix, so the t
sue may be further processed at once
at any desired later time. It is wash
in 70A, stained in buffered Delafiel
hematoxylin until the nuclei in the ce
are a good blue, washed in 70A, deh
drated to 95A, counterstained in eo
Y for thirty seconds, washed in 95A, th
in 100A, xylene, and mounted. A pin
of picric acid crystals or of lithiu
carbonate is added to each of the
agents when Bouin's fluid is used.

Whole mounts of hydra, worms, pa
sites, embryos, and other organisms a
treated similarly, except that a sin
stain is usually preferred, such as one
the carmines. After fixing and washi
the organism is stained, then wash
dehydrated, cleared, and mounted.
its second usage, xylene is miscible wi
both the alcohol and the mountant,
it does something else, too: it oils
material and thus renders it transluce
preventing an opacity that would
objectionable in a finished slide pr
aration. Hence xylene is classed as
clearer, and it is listed among the ma
other clearing agents.

Instead of the somewhat tedious al
hol series for hydrating and dehydrati
the technician may shorten the proc
by using either Dioxan or Cellosolve,
agents that are miscible with water, al
hol, or xylene.

We shall have more to say abo
smears and grinding operations in lat
installments, but enough informati
has been presented here to give a g
eral outline of the steps involved in p
paring a finished microscope slide.

This list details the photographer, arti
or other source of illustrations, by pag

COVER—Lee Boltin
4—Joseph Sedacca
10—Carleton Ray
11-20—Russ Kinne except 12, 13, 14-bottom; 17; 19-center and bottom, and 20-bottom—Carleton Ray
21—Carleton Ray
22-27—J. J. Petter
28-35—Y. Shehori and M. Rosenberg except 29-bottom, W. Braun; 30-bottom, P. Groszmann with Y. Yitzhaqi; 31-bottom,
Groszmann with Y. Yitzh
after Bentor and Vroma
36-37—W. Chaloner
38-45—Lee Boltin
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58—Sky Map, after Henr
M. Neely
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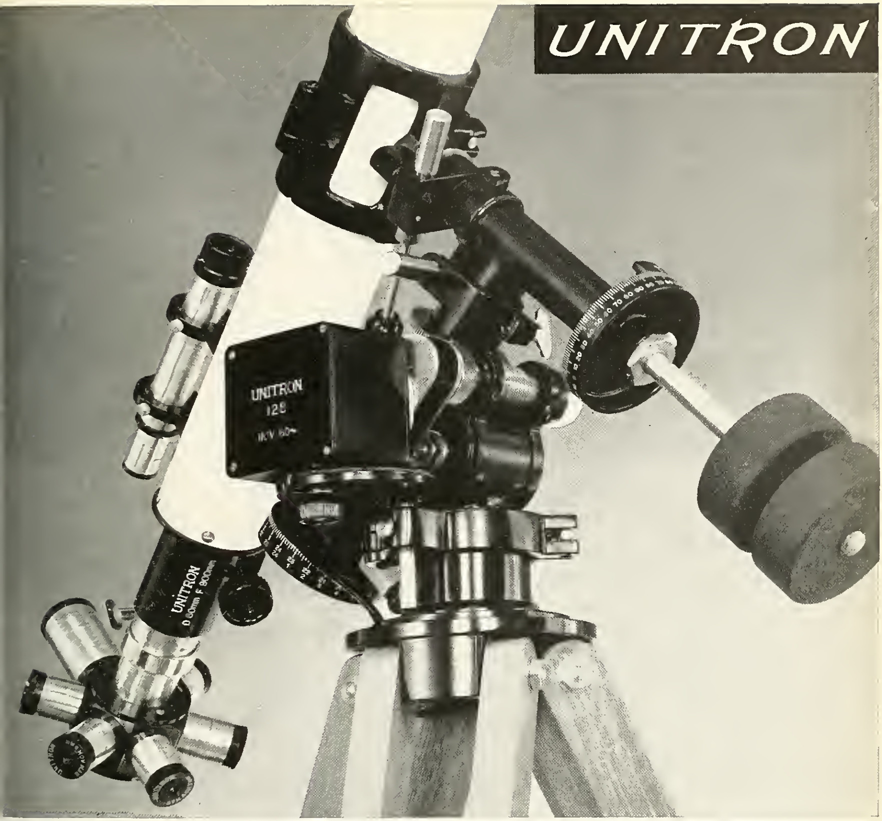

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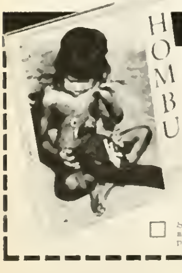

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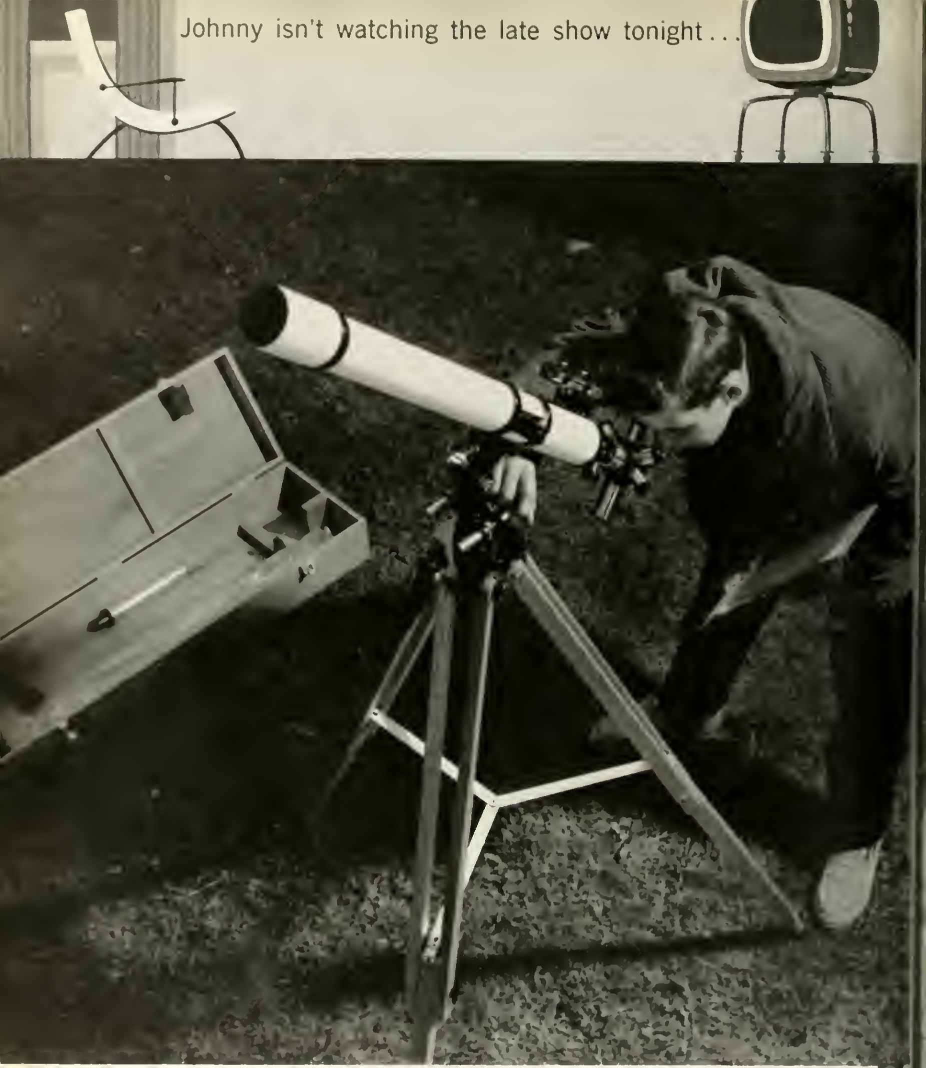
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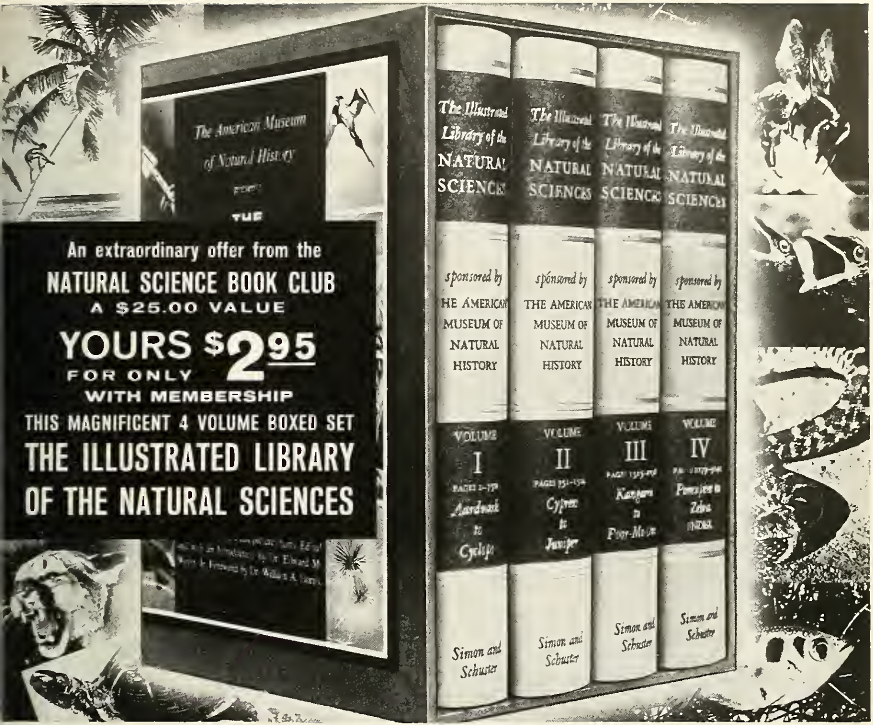
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NATURE AND THE CAMERA *David Linton*

COVER: A man in the group of Tiwi natives living on Melville Island, in t
Timor Sea, paints his face while participating in the Tiwi's annual, three-
Kulama ceremony, which is named after a toxic yam. The Tiwi who still adhere
tradition believe that great powers for good or evil dwell in *Kulama* yams, a
that one must participate in their ritual preparation if one is to benefit fr
these powers. For those young Tiwi men and women who undergo the six years
instruction in the ritual, it represents a formal initiation into adulthood.
Jane C. Goodale discusses this ceremony in the article that begins on page

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N. Y. Published monthly, October through May; bimonthly June to September. Subscription Price: $5.0
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Reviews

Old Snowman myth melts; glacier fallacies compounded

By William R. Farrand

High in the Thin Cold Air, by Sir Edmund Hillary and Desmond Doig. *Doubleday & Co., $6.95; 254 pp., illus.* The Great White Mantle, by David O. Woodbury. *Viking Press. $4.95; 214 pp., illus.* Antarctica, by Roger A. Caras. *Chilton Co., $6.00; 209 pp., illus.*

Accounts of high mountains, mountain people—both abominable and real—glaciers, and startling climatic changes during the Ice Ages are always captivating, and they appeal to a wide audience. In the past, much that was written on these subjects strayed into the realm of science fiction to explain some of the bizarre phenomena that explorers and scientists had uncovered. But now major research efforts, such as the recent International Geophysical Year, are providing information that generally rules out the more fanciful solutions and substitutes less dramatic explanations. The three books reviewed here relate accounts of present-day scientific attacks on little-known areas and, with varying degrees of success, bring the findings of modern explorer and scientist to the lay world.

In 1960-61, Sir Edmund Hillary (who must know the Himalayas as well as the back of his hand) led another expedition *High in the Thin Cold Air* of Nepal. His expressed aim was twofold: to find the Abominable Snowman and to study the physiology of human acclimatization to extreme altitudes.

The first half of the book is written by Desmond Doig, assistant editor of the Calcutta *Statesman*. He gives an interesting and very readable account of tracking down bits of evidence usually cited as support for the existence of the Abominable Snowman of the high Himalayas. There are actually three types of Snowmen reported by the Sherpas who live in the region (and various western explorers). They are known collectively as *Yeh-teh*, and include the large, shaggy, brown, cattle-eating *Dzu-teh*, common at 15,000 feet; the man-eating, apelike *Mih-teh* with black or red fur, a high conical scalp, and reversed feet found above 16,000 feet; and the small, ginger-colored *Thelma* found in forests below snow line. Doig is fluent in the Sherpa language and goes directly to sources to examine the supposed evidence. In the company of Hillary and a number of well-known zoologists, he finds that the *Yeh-teh* footprints are, in all the cases examined, hoofprints or pawprints of bears, goats, or snow leopards. The prints have been melted into grotesque forms by the warm Himalayan sun, and when traced into a shadowed area and examined, they are found to have recognizable proportions and shapes. Other important bits of evidence are *Yeh-teh* skins and scalps, generally owned by lamaseries. The skins turn out to be those of the rather uncommon Himalayan blue bear, and the scalps have been artificially fashioned from the hide of a goatlike animal, the serow. Only the high-pitched call of the *Yeh-teh* was not examined—or even heard—by the expedition during several months in the heart of *Yeh-teh* country.

One of the strongest reasons for persistent belief in the *Yeh-teh* has been the absolute faith of the Sherpas in the creature's existence, even when shown the sun-melted tracks and the blue bear hides. However, there now seems to be little room left for a rational belief in an Abominable Snowman. Doig has done an admirable job of reporting his observations, but he seems a little regretful when he is forced to reach his conclusion that the *Yeh-teh* must be relegated to the "sphere of fantasy."

The second part is written by Hillary himself, who once again proves to be as colorful a writer as he is a person. The prime purpose of this expedition was to take a relatively large number of men who were accustomed to sea level conditions to altitudes of 16,000 to 19,000 feet for nine months to test their ability to adjust to thin, cold air without the use of supplemental oxygen. Although appetites fell off, and lack of oxygen limited physical activity, the men held on relatively well until the final test—the ascent of Makalu, the world's fifth highest peak—without oxygen. In the Himalayas, this 27,790-foot mountain is not an extremely difficult climb, but several mistakes, coupled with the generally weakened condition of the men, terminated the assault just four hundred feet below the summit. Hillary reluctantly concludes that sea level man cannot

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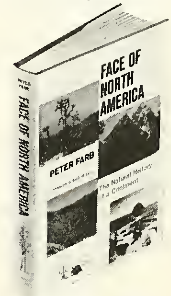

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acclimate, even over a period of nine months above 10,000 feet, and that it is impossible successfully to climb the high Himalayas without an oxygen supply. This very readable book is highly recommended for its coverage of the *Yeh-teh*, human adaptation, climbing exploits, and for its warm insight into the lives of the Himalayan Sherpas.

The other two books are of much less merit. Both misrepresent their subjects to some degree and one wonders if this unhappy situation can be attributed to the fact that the authors are reporters rather than scientists.

In *The Great White Mantle*, David Woodbury begins with contemplation of "Whitey," a large, erratic boulder on the coast of Maine. From this point of departure, he looks at the life cycle of continental ice sheets telescoped into one grand "year." In chapter nine we are finally introduced to some real facts about glaciation on a realistic time scale. The evolution of man, the origin of the Great Lakes, and the methods of dating Ice Age events are discussed as a background to a treatment of some of the causes of glaciation.

The outline is fine, but Woodbury has done a very uneven job of filling in the skeleton. Some of the treatment is up to date, but in other areas recent studies are neglected. Furthermore, the author's rambling style avoids a discussion of glaciation, while at the same time throwing in an entire course in geology, much of which is not necessary for understanding the book. In addition, he spends an entire chapter developing an irrelevant concept of telescoping geologic time. The unfathomable lengths of geologic time *are* unfathomable, which is perplexing, to be sure, but Woodbury is in danger of misleading the general reader when he says that geologists are more comfortable when they are dealing with millions of years.

A long list of errors, misstatements, and misconceptions clearly demonstrates the author's lack of familiarity with his subject. An example is his naïve and completely erroneous conception of the mechanics of glacier movement. Also, he retains the now-discarded reconstruction of Neanderthal man as a crude, gorilla-like creature. Any value this book may have is overshadowed by the numerous fallacious ideas that are included.

Roger Caras' *Antarctica* is more palatable, but is marred by poor organization and some uninteresting, repetitive writing. Some sections are excellent and move at a quick and exciting pace. Especially good is Caras' treatment of the history of exploration in the Antarctic. Also, the two chapters devoted to whales and penguins of the Antarctic Ocean are informative. But one has the impression, upon completion of the book, that he has skipped a chapter. Where does the author describe the great ice sheet tha covers 90 per cent of the continent. Abundant published information ha been available since the Internationa Geophysical Year, but we find no systematic presentation of it here, and only bits and pieces are scattered through th book, mostly in the last chapter, whic discusses "Unsolved Mysteries. . . ." About forty pages are devoted to appendixes, which include the text of th Antarctic agreement, place names, expeditions, philately, and even how t care for a camera in such a cold climate However, uneven treatment of Antarcti subject matter detracts from the book

The most disturbing fact about bot these latter volumes is the unnecessary exaggeration and emotionalism that i apparently employed to interest the lay reader, but only succeeds in drawing totally unrealistic picture of a workin scientist's world.

Dr. Farrand is Assistant Professor o Pleistocene Geology at Columbia. He als is with Lamont Geological Observatory

SYSTEMATIC DICTIONARY OF MAMMAL OF THE WORLD, by Maurice Burton *Thomas Y. Crowell Co., $7.50; 30 pp., illus.*

THERE is a great need for a book tha will bring together in one place concise, accurate, and up-to-date summarie of what is known of all mammals of th world. Although the book jacket Burton's *Systematic Dictionary of Mammals of the World* claims that, "In thi concise but comprehensive handbook practically all the world's mammals ar described in detail," the truth is that th book is incomplete, frequently inaccurate, and often out-of-date. In the introduction, the author excuses these shortcomings on the grounds of unavailabilit of information for many species and lac of space to deal with information that i available; he also admits that the bul of the book was prepared ten years ag and has not completely been update Inasmuch as more than 15,000 scientifi papers and books on the mammals of th world have appeared in these ten year it is not surprising that Mr. Burton' book is found lacking in many regard

Each species is presumably dealt wit under the headings of general characteristics, habits, habitat, food and feedin habits, breeding, present status, range longevity, and additional data. However these categories are used for fewer tha half of the species of mammals of th world, while the remainder receive passing mention, if any. This is not for wan of information, either, as evidenced b only five lines devoted to the America black bear, five lines to the gray fox three lines for some sixteen species o

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western United States chipmunks (and no mention of the Asian ones), and six lines for the bobcat. Space is used most uneconomically in the book, and perhaps one-fourth more information could have been included with a different arrangement of data.

The ranges given for many North American mammals, for which the most accurate ranges are known, are highly inadequate. The range of the American opossum (which is given an outdated scientific name) is shown as no farther south than Mexico (it ranges to Argentina), among other errors. The book's orientation is mostly British, neglecting other areas. South American mammals, especially, receive scant attention.

In sum, then, Burton's book cannot be recommended because of its dubious information and incompleteness.

Richard G. Van Gelder

The Earth, by Arthur Beiser. *Time, Inc., $3.95; 195 pp., illus.*

A glance through this book cannot fail to impress the reader with the pictorial beauty of the earth, the skies above it, and its setting in space. As a professional geologist, I expected the book's value to stop there. I was gratified to find, however, that within the limitations imposed by space, the volume goes well beyond a satisfying artistic presentation. The abundant photographs, many in color, are intelligently chosen to illustrate pertinent facts and important concepts. The text is lucid, judicious, and in many areas goes straight to the heart of the intellectual problems presented by geology and meteorology. In short, a reader desiring a capsule summary of this field can, with a minimum of eyestrain, profitably read this book.

John Imbrie

Handbook of North American Birds: Vol. 1. Loons Through Flamingos. Edited by Ralph S. Palmer. *Yale University Press, $15.00; 567 pp., illus.*

Of the myriad books on birds published each year, possibly one or two rank as truly outstanding and valuable additions to the bird watcher's ever-expanding library. The appearance of this first volume of a projected series establishes a landmark in North American ornithology that is equaled in significance by only three other publication dates: 1886, the first edition of the *Check-List of North American Birds;* 1901, the first volume of Ridgway's *Birds of North and Middle America;* and 1919, the first volume of Bent's *Life Histories of North American Birds.*

The *Handbook*, a multivolume endeavor sponsored by the American Ornithologist's Union and the New York State Museum and Science Service, is de-

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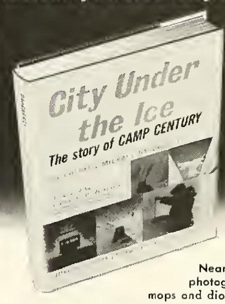

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signed to provide concise, authoritative accounts of our knowledge of over 1,600 species and subspecies of birds that occur in North America north of Mexico. Possibly ten volumes will be required to accomplish this Herculean task.

Twenty-six contributors have digested and summarized a vast amount of published material for this first volume, and the extensive bibliography may well prove to be the most useful feature of the *Handbook*. The series also serves as a place for publication of original data. The style is telegraphic for the most part, with the usual lack of uniformity inherent in such co-operative works.

Covered in this first volume are those birds listed up to the waterfowl in Wetmore's classification. There are brief diagnoses of orders, families, and genera (including the fossil record). Each species account consists of a diagnostic description (using the Villalobos color system), plumages and molts (following the terminology of Humphrey and Parkes), measurements, geographical variation, field identification, voice, habitat, distribution and migration, banding data, habits, egg profiles and measurements, and food. The range maps, often a full page in size, are generally well done and, if read as intended, constitute a useful feature of the species' accounts.

The species entries are variable in length, though the coverage is in greater detail than that of the *Handbook of British Birds*. Only one-half page is devoted to the least frigate-bird, of which there is one record based on photographs taken in Maine and published while this volume was in press. The common loon and a few others are given up to fifteen pages of text while most species receive from five to ten pages.

The editor's adoption of the nomenclature for plumages and molts, as suggested by Humphrey and Parkes as recently as 1959, is perhaps the most controversial feature of the new series. This dramatic departure from tradition has been viewed by some as nothing short of catastrophic and calamitous for the science. Should the new system become more generally accepted with the test of time, as I predict that it will, Palmer will be acclaimed for his vision and service. Meanwhile, there is a conversion table for dissenters and skeptics.

I offer one constructive criticism of this first volume. For the most part, the contributors have been reluctant to admit to the gaps in our knowledge. It is to be hoped that contributors to future volumes will freely indicate, indeed stress, areas where more data are needed or where none exist. This is potentially one of the greatest services of such a series, and would benefit students, researchers, and amateurs alike.

May the editor have the patience and fortitude to carry this project through

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SOME time ago the Laboratory of Ornithology at Cornell University issued records to accompany Roger Peterson's well-known *Field Guide to the Birds of Eastern North America.* These records made for rather hard listening; they consisted of a repetition of the numerous names of the birds and the page on which they appear in the *Field Guide*, followed by an often very brief snatch of song or voice. While it seemed dubious as to just how useful such an approach would be, apparently the venture was well enough received to suggest doing the same for Peterson's revised *Field Guide to Western Birds*, and the results are before us. The records have been made a little less monotonous by grouping the renditions in sections of about ten pages each, thus eliminating the need of continually referring to a page. Nevertheless, I find the records unsatisfactory. No one is really going to learn the songs by listening to these brief fragments. Furthermore, the Cornell Laboratory may justly be proud of its scientific achievement in amassing large numbers of recordings, but merely because someone has taped the squeaks of all the half-dozen or so hummingbirds of southern Arizona, it does not mean that they should be inflicted upon the purchaser of a popular record. Many of the other recordings are equally meaningless for general purposes—for example, a barely audible clucking noise is attributed, of all things, to a golden eagle! Easily one-third of the recordings could have been eliminated as contributing little or nothing to a knowledge of bird songs.

Another one-third might have been eliminated because they belong to eastern birds, such as the great-crested flycatcher, the black duck, the blue jay and literally dozens of others. While it may have been necessary to include all these species in the *Field Guide to Western Birds* (although I would be happy to argue the point), there is certainly no need to repeat them on the two sets of records. Thus cut down, the chore could have been handled on two, rather than three, records and there would still have been ample time for a proper statement

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It is a pleasure to turn to the two smaller but better-conceived records, both of which are essentially introductions to many of the commoner and better-known eastern song birds. The standard of recording has now improved to the point at which even difficult, high-pitched songs are clear when played on a record player of moderate quality without hi-fi equipment. There is little choice between the two; the approach is somewhat different and one may listen to both of them and decide for himself. Personally, I prefer the *Bird Songs in Your Garden* album in which, on the reverse side of the record, the songs are played without any voice commentary.

DEAN AMADON

THE UNIVERSE, by David Bergamini. *Time, Inc., $3.95; 192 pp., illus.*

This volume in the "Life Nature Library Series" is a richly illustrated review of modern astronomy and the universe. In very lively prose and in colorful and dramatic pictures, *The Universe* presents a panorama of astronomy from the earliest myths and legends to the latest problems of cosmology.

Each of the eight major divisions of the book tells its story in two forms, first in dramatic narrative style, supported by simple line sketches, and second in the form of thoroughly captioned picture essays. The subjects covered are: the background of astronomy, the methods and equipment of astronomy, the members of the solar system, the structure and evolution of the sun, the stars and nebulae of the Milky Way, the origin and evolution of the stars, the universe of exterior galaxies, the origin and structure of the cosmos in space and time. The text and picture essay dealing with the sun are especially well done.

The prose narrative and picture essay arrangement in this book make it particularly attractive for the casual user who may scan it for a few hours or perhaps for shorter periods several times over. Its appearance and impact are enhanced by the large number of vivid, full-color illustrations, including many color photographs of celestial objects. The more thorough reader, who goes through the book carefully from cover to cover, may be disturbed by the repetition of subject, phrasing, description, and explanation in the parallel forms. From the manner in which some terms are used and explained several times in the same way, one suspects the book was not meant to be read at one sitting.

Nevertheless, *The Universe* is a beautiful book. Its illustrations are lavish, well chosen, and largely well reproduced. The text is exciting and gives lucid descriptions and explanations of some of the most difficult and interesting work in modern astronomy. I hope, however, that readers will not spend too much time looking for the comets described in the table on page 70 as "best-known comets visible to the naked eye from earth." Some of these are among the faintest known—much too faint to be observed by the naked eye.

THOMAS NICHOLSON

BIRDS AND WOODS, by W. B. Yapp. *Oxford University Press, $5.60; 308 pp., illus.*

A readable, stimulating account of British woodlands and the birds inhabiting them is here presented by W. B. Yapp. Historical factors are considered along with the dynamics of present-day avian populations. He points out that some 9,500 years ago Great Britain was connected with Europe and covered by glacial ice (except for tundra in some parts of the south and west). As the ice began to recede, first tundra, then coniferous forests, and finally deciduous forest reached the region. The subsequent rise in sea level, as deglaciation continued, cut the heavily forested peninsula off from Europe. According to Yapp, the woods today are highly modified remains or copies of the prehistoric woodlands, and England today has but 4.6 per cent of the woodlands that were present as late as Roman times. In view of such sweeping changes and the intensive regulations of existing woods, Yapp is occasionally misleading in his discussion of "natural" and "unnatural" (i.e., man-modified) conditions. Obviously all the woodlands he speaks of are in some degree "unnatural."

Attention is paid to the zonal distribution of birds in the woods, density-dependent and non-density-dependent factors influencing population size, the functions of bird song, peck order, and an array of topics relating to woodland bird communities. The presentation is well integrated, and the views expressed are generally sound, except for certain points concerning subjects with which the author has not dealt in his own investigations, such as speciation and flocking behavior. In his evaluation of various factors that limit the distribution and numbers of British woodland birds, he concludes that weather, food supply, and the presence of suitable habitat are of primary importance, while others—such as predation—are unimportant. Included are many examples of distributional problems, among which is the amusing similarity between the distribu-

n of the cirl bunting *(Emberiza cirlus)*
d that of health resorts in England!
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ing the final quarter of the book) and
the many tables scattered through the
ok. This hampers comparison of in-
rmation presented for related forms.
The book contains a number of photo-
aphs of the woodlands considered,
awings of various woodland birds,
aps, and tables. Although it deals with
t one area, those interested in wood-
nd birds will profit from this book.

L. L. SHORT, JR.

AN AND THE SUN. by Jacquetta Hawkes.
ndom House, $5.00; 277 pp.

HE beginning point of Jacquetta
Hawkes' *Man and the Sun* is an ac-
unt of the creation of the sun itself.
er which the author steers a nicely
ective course through astronomy, pa-
ntology, and human history without
r being either diffuse or skimpy. As
tells the story, the sun gave birth to
physical form of our earth and sta-
ized it in space, then inspired life
on it. Life became conscious, and in
human subdivision grew an awareness, intellectual as well as intuitive, of dependence upon the sun. This sense of necessity developed into the great early religions. But then, as man's intellectuality increased, he abandoned worship and launched into investigation. Today he is himself able to create small suns—bombs—which give him tremendous powers of self-destruction. It is, as Miss Hawkes says, a "most curious cycle" and, so phrased, a terrifying one.

In presenting this synoptic view of the sun's life span, Miss Hawkes uses the most recent theories and sources. I, for one, regret losing the apocalyptic glories of our old vision of the earth's beginning as a superheated mass of material, rent by volcanic action as it cooled. On the other hand, I am fascinated to learn what astronomers now surmise actually did happen, and what they think about the appalling events due to take place 5,000 million years from now. We will never know whether they are right on either score. With Miss Hawkes' accounts of early Europe, Mesopotamia, Egypt, pre-Columbian America, and Asia, we have a better chance. A distinguished archeologist in her own right, she is on firm ground here. No one can have written better about the personality of that most mysterious Pharaoh Akhenaton; and the sketch of Western sun worship, from the Bronze Age Indo-Europeans to Mithras, is a brilliant feat of compression. It is refreshing, too, to encounter a writer whose humanity extends to an unashamedly moral view of the distant or exotic past. It is expressed here in a vivid account of the sickening rites of the Aztec "Sun of Death."

And so to modern times and the real point of the book, which is intended to be much more than popularized scientific history. *Man and the Sun* is really a deeply felt, philosophical, even semireligious work, with haunting overtones of one of the greatest world views of the past: the conception of the universe as macrocosm and microcosm, complementing and echoing each other. A scientist by training and long-practiced discipline, Miss Hawkes also avows her adherence to vitalism and teleology. Unless I misread her badly, she is advocating—or at least hopefully heralding—a return to some new religious feeling. She speaks of the "Sun of Life"—as Akhenaton knew it—as its leading emblem. Well, perhaps. Many, probably most, of her readers will not be able to follow her in this. But it should not impair anyone's pleasure in the closely packed riches they can find here, even if they read the book only as a magnificent blend of erudition and speculation in the tradition of Sir Thomas Browne's *Urne-Buriall.*

DOUGLAS NEWTON

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Qualifications for Adulthood

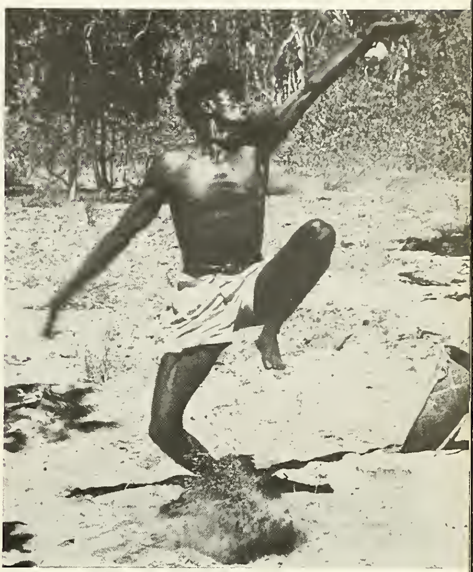
Tiwi invoke the power of a yam

By Jane C. Goodale

In 1912 Sir Baldwin Spencer. a professor of biology at the University of Melbourne. visited Melville Island, in he Timor Sea. There he observed a Tiwi tribal ceremony in hich a number of young boys and girls participated in the itual preparation of a species of yam the Tiwi called *Kulama*. Spencer wrote of this ceremony, "initiation of oung men [and women] on Melville Island is intimately ssociated with what is known as a yam ceremony." This tatement is particularly noteworthy, for, in 1954, when I isited the Tiwi for the first time and witnessed the annual *Kulama* ceremony, no initiates took part. The ceremony, owever. was still being performed with no significant hanges in the complex ritual procedures that Spencer had escribed more than forty years before.

That the *Kulama* ceremony can and does take place without initiates does not mean that Spencer was wrong to consider it an important part of initiation into adult life. It oes mean that many of the new generation of Tiwi believe hat such participation cannot prepare them adequately or a way of life that has been radically changed by contact ith Western culture during the past fifty years.

In order to understand what this ceremony means to hose who still perform it. one must first understand what he Tiwi consider to be adulthood. The Tiwi. now about a housand in number. have lived for untold centuries on Melille and Bathurst Islands, which are situated thirty miles orth of Darwin, the capital city of Australia's Northern Territory. The islands and surrounding waters are well upplied with food, and fresh water is plentiful. Economically and technically the Tiwi have been remarkably onservative. They came to the islands as hunters and gathrers of wild food, using crude chipped stone axes, diging sticks, simple wooden spears, and hunting dogs, and ound that little else was needed to exploit the natural reources and to provide themselves with a stable, varied, nd adequate diet. With the exception of the wallaby. the and animals of the two islands were small and nocturnal nd could simply be collected during the day with little hysical effort or skill. The few skills that were necessary ere identifying tracks to find game and chopping out or igging up the sleeping animals. Young boys and girls were aught these techniques, since there was no essential sexual ivision of labor in food-collecting. Boys, however, received additional instruction in spear-fishing and birding, while girls were taught more intensively to locate and identify edible plants. The children. as a result. were generally independent economically in their early teens. by which time the girls were already married. Young males contributed to their parents' larder and to other households. but did not marry and acquire households until they were more than thirty years old. Even now, this late marriage age obtains in theory, but not always in practice.



Shark dance is among traditional, imitative figures that are performed during ritual preparation of toxic *Kulama* yams.

Thus, to the Tiwi, economic independence and/or marriage did not alone signify adulthood. The Tiwi adult was intellectually. rather than physiologically. a mature individual who was expected to join actively in the non-economic affairs of the community. An adult was also expected to be almost entirely responsible for his own health. wealth, and future prospects. This included attaining success in hunting and in war and, for the men, in wife-collecting. If an adult became ill or was injured or, as a Tiwi would say, was unlucky in the pursuit of life's benefits, he alone was responsible for not behaving as an adult should.

The annual *Kulama* ceremony, held by each community in April at the end of the rainy season, was a most important event to insure individual success. Although a collec-

iwi native on Melville Island expresses a grievance in an riginal song during the annual three-day *Kulama* ceremony.

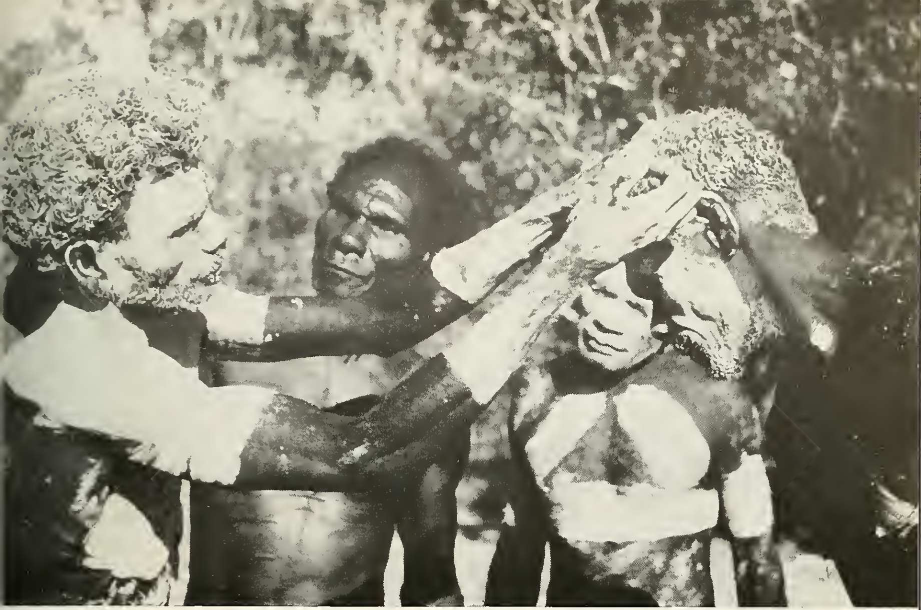
BEFORE DIGGING YAMS, the ritual participants dip hands into white paint and pat it around eyes to insure acute vision.

CEREMONIAL RING is prepared by clearing ground of grass, sticks, and stones. Participants will sing and dance there.

tive, community ceremony, its benefits accrued only t individual participants, and then only to those who ha followed the complex procedures correctly. Thus it wa vitally important to every Tiwi individual, male or femal to receive instruction in the *Kulama* ritual before bein considered a fully adult member of the tribe. The instruction period lasted six years, during which the initiate among other requirements, had to participate active'y i six *Kulama* rituals. Following this training, the individual were considered responsible adults by other members o the tribe, but only through continued participation in th ritual could that condition be maintained.

TODAY the ritual is still performed by those who believ in it, and it will probably continue until the last initiated Tiwi dies, or until the underlying meaning is totall lost and is replaced by ideas of how to be successful tha have their origins in Western thought.

The ceremony itself takes three days to complete an centers on the preparation of a toxic variety of yam, th *Kulama*. To make this yam edible, it must first be soaked It is then baked, mashed, and again soaked for a time i fresh water. Even after the poisons have been removed b this elaborate process, an extremely bitter taste remains The Tiwi say they never eat the yam except at the conclusion of the *Kulama* ceremony. Those who believe in th ritual say the yam has tremendous power for causing goo or evil, and thus one must handle the yam carefully durin the preparation, speak to it softly, sing to it at times, an always treat it with respect. The individual absorbs th power of the yam by touching it, by rubbing the body wit it, and finally by eating it. All these steps are ritualized Special digging sticks are made, and, contrary to the usua practice of having the women gather plants, only me



Rubbing paint into the hair is supposed to prevent illness, and daubing it on the arms and legs wards off broken bones.

re allowed to dig the yam. A special dance area, or cere-
onial ring, is cleared on the ground and a special cook-
g fire is built in its center. On each of the three ceremonial
ays the participants paint themselves in specified ways
ith ocher. During the evening of each day, while the yams
re soaking or cooking, the male participants, singly or
gether, walk slowly counterclockwise around the cere-
onial fire, beating sticks together as an accompaniment
specially composed songs. At times the wives, who re-
ain outside the ring, sing with the men, or they may join
eir husbands in traditional dances that imitate various
spects of the natural world around them.

The songs are a vital part of the ritual. They must be ewly composed for the occasion and may relate to any vent or abstract idea the composer chooses. The songs ften deal with injustices the singer has experienced in the ast year. about which he wishes to register an "official" omplaint:

"There was a funeral,
You went first. I came after.
Old people came in first.
I was late because I had a *Kulama.*
Why didn't you wait for me?"
or
"When Dory have baby girl
The old man said. 'That's for you.'
Dory, my mother-in-law, she burns me.
Dory doesn't know the old people way.
I would like to kill her."

thers may be in the nature of news reports, in which the steners are informed of anything interesting that may ave happened to the singer during the preceding year. or instance, the composer of the following song had just

Stakes are set in the center of cleared area to hold mound of sticks and pieces of anthill that will be burned later.

Yams to be used in *Kulama* ceremony are retrieved from a fresh-water pool in which they had been soaked overnight.

Young girl and boy accompany fathers as men bring yam from pool to the ceremonial ring. There the yams will b

returned from Brisbane, where he and a group of eight other aborigines had performed dances in honor of Queen Elizabeth's 1954 visit to Australia:

> "The Queen was talking in England,
> 'I would like to see a blackfellow dance.'
> When I was in Brisbane, the Queen said,
> 'I would like to meet a black boy!'
> And I went up.
> King Philip, he had a good look at me.
> He was watching a lot as I danced.
> I was singing into a loud-speaker."

Some songs are historic in nature, retelling an event that must be kept alive according to the traditions of the tribe. One such composition recalls the Japanese attack on Darwin during World War II:

> "An enemy plane flies low over Melville Island.
> The men on the ground, at the word 'Standby,'
> Shoot it down with a cannon."

The children of the singer are often song subjects. This first example describes how the children behaved in one of their father's dreams.

> "My children have gone to the other side
> of the island.
> But they most come back as they are hard up
> for tobacco.
> My children have now come back.
> I know this for they have taken the tobacco
> which I have held in my hand."
> or
> "My children will wear clothes and shoes.
> They will go to school and learn to write."

All the songs have the same chanting tune, which is associated with the *Kulama* ceremony, and the composer must fit his words to the set meter of the chant. In many cases this requires using archaic words that are no longer a part of Tiwi speech. Poetic license in pronunciation an syllabification often occurs. The Tiwi have high regar for the linguistic ability needed to become a good Tiw composer and singer, and instruction in the art of son composition and delivery is given to the initiates. Each in tiate must perform in the *Kulama* before he can be consid ered a "graduate." According to my Tiwi informants, th requirement is the hardest of all, and it is also the reaso for there being no set age for initiation. The old people ar said to watch the young, and when the observers conside them mature enough, they swoop down upon their choic "like chicken hawks, without warning"—as the Tiwi say and start the initiates along the path to adulthood.

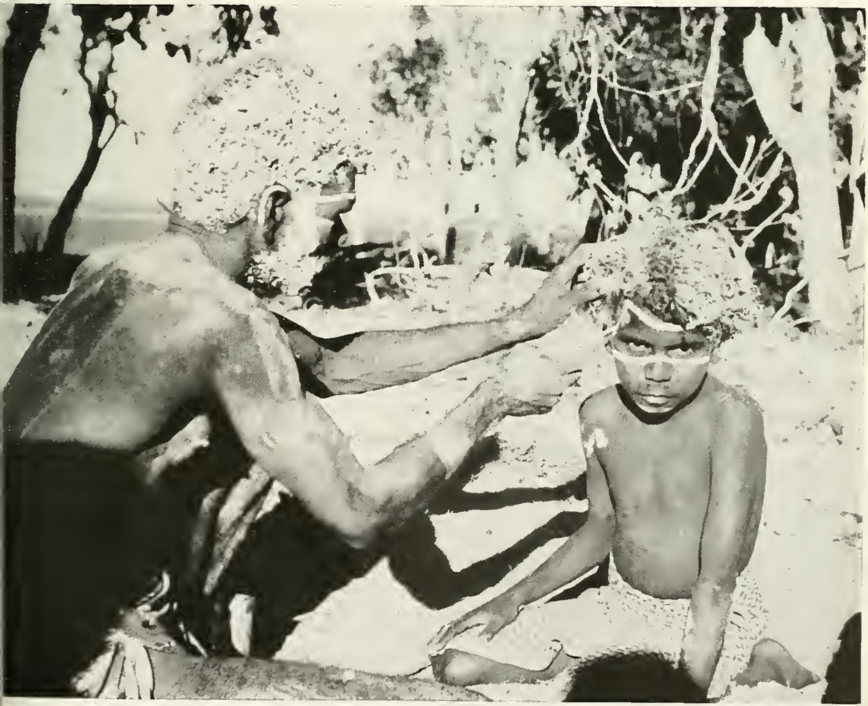
As far as I know, the *Kulama* ceremony has no parall elsewhere in Australia. And there are many interes ing questions that come to mind concerning the origin the *Kulama* as it exists today. For instance, why is instru tion in the preparation of a poisonous yam that is not pa of the daily diet considered so important for initiation int adulthood? What is the origin of the idea that a yam ha power over good and evil, and health and sickness? Wh is such prominence accorded a yam in what is principall a hunting and gathering society?

Any answers to these questions must be highly specula tive, for the origin of the ceremony and its developme lie in the unrecorded history of the Tiwi. However, I be lieve the following statements may well be valid.

Instruction in the natural resources of the land was con sidered vital to becoming an adult. Because the *Kulam* yam is poisonous and is not widely distributed, it wa never part of the regular diet, but it could be used in ec nomic emergencies if properly prepared. Instruction in i preparation was therefore extremely important as a pote tial survival measure. However, since the Tiwi live in favorable environment, it is highly probable that su emergencies were very rare, so it was considered expedie to hold annual instruction periods. Because knowledge

baked by placing them atop pieces of anthill heated to a glow by wood fire, then covering the yams with hot earth.

Man lights fire beneath chunks of anthill. When the pieces are red-hot, burning wood below them will be brushed away.



ather paints girl to show how it would be done if she ere to be initiated. Although no children of group were considered ready, ceremony was held to maintain benefits thought to accrue to the Tiwi who had undergone initiation.

Hot earth over baked *Kulama* yams is removed. Yams that are to be eaten at end of ritual must be resoaked in water.

Some cooked yams are cut, peeled, and mashed. Water and paint are then added. Yams are always handled with respect.

Men rub mash on bodies to insure health, then do so to the uninitiated young, whose health is paternal responsibility.

the technique had to be made meaningful to the initiates, the lifesaving qualities of this famine food were explained as health-giving powers. A ceremony accompanied by song and dance was certainly a dramatic and effective means of impressing the initiates in preparation methods. The ritual served another purpose as well: because traveling is so difficult during the rainy season, each household is isolated from the others. The *Kulama* ritual follows this period, and it is natural to expect a reunion to be an occasion to exchange news, settle differences, and tell stories or sing songs that keep traditions alive.

Much harder to account for is the Tiwi idea of adulthood. That every adult is solely responsible for his own health and wealth, and that success in life depends entirely on personal behavior and industry, are ideals strangely similar to those that underlie the American way of life, despite the great gulf between the aboriginal cultur and our own. But it is not at all surprising that the Tiwi have a great sympathy for much of Western civilization. Many hold the same views as the *Kulama* singer quote earlier in this article who saw his children wearing clothe and shoes and going to school to learn to write, for this i the Tiwi's contemporaneous idea of success in a way o life introduced to them only a few short years ago.

Early in the summer of 1962 I revisited the Tiwi fo two weeks. Although I knew that the Tiwi desired schooling and training in European ways of life and would seiz any such opportunity afforded them, I was hardly prepare for the tremendous changes that had taken place during th eight years that had elapsed since my first visit.

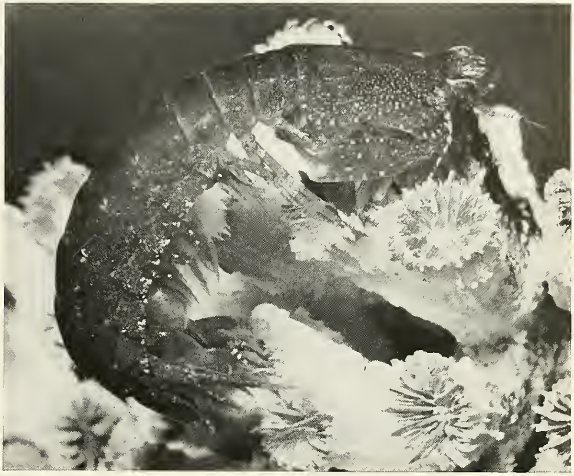
Three months after the *Kulama* ceremony of 1954, government school was opened. Now all the Tiwi childre go to school, and some who have finished the six-year program in the government school have received subsequen training as teaching or nursing assistants. Some other have had "on-the-job" training in various activities connected with a large-scale forestry project that has bee started on Melville Island. In fact, all the able-bodie Tiwi men and women are currently employed, and thei tasks bear little or no relation to their old life in the bush

It is perhaps significant—but to me not at all surprisin —that I did not hear a single real complaint from the Tiw regarding their new manner of living. They seem to lik it and are anticipating bigger and better things (in th Western sense) for their children. Hunting has becom a week-end diversion and the children receive little or n real instruction in that traditional skill.

Some aspects of Tiwi life are slow to die, however. Mos of the old taboos, the observance of which was considered necessary in the past in order to insure health an wealth, are still observed, although at least one teen-age expressed doubt that the taboos had any actual effect o the outcome of one's life. Western medicine and publi health practices are fast replacing belief in the *Kulama* During the past eight years only three men have begun th six years of training for *Kulama* initiation, and some of th older men no longer participate in the ceremony. However as long as even a small number of Tiwi believe in the *Kulama*, the ritual will survive, but I doubt that it will for long

Near end of *Kulama* ceremony, performer, although hoars and tired, must continue to sing until late in the night

A MARVEL of delicacy is the banded coral shrimp, found in the nooks of coral colonies.



SQUILLA, or mantis shrimp, is an emerald green; it usually lives in the crevices of coral.

Beauty and Science

Nature's form and color delight the seeker after knowledge

By MEREDITH L. JONES

OBVIOUSLY, THE ABILITY to perceive objectively is an integral part of any scientist's approach to his subject. The popular conception of the professional biologist clothes him in an immaculate white laboratory coat, gives him a cold, perceptive eye, and endows him with an efficient, objective mind. To a great extent, this is an accurate picture. But the cheerless, dispassionate outlook implied by this unapproachable image is often tempered and humanized by a hidden fascination and appreciation for the pure beauty exhibited by the various plant and animal groups. Of course, this cannot be admitted, for the world might question the motives and capabilities of a scientist who rhapsodized about the construction of a stamen, the graceful soaring of a hawk or vulture, or the brilliant flashings of iridescence from the elytra of a beetle; for in a discipline of objectivity, subjectivity is suspect.

Consider, then, the dilemma: to work with miracles of color and form and yet to have to maintain a proper aloofness and impassivity, and deny that one is moved by the specimens one examines and by the very fact of life, itself. But there is an out. Like James Thurber's Walter Mitty, all of us have our secret lives, no less the professional biologist; and one of these is given over to the examination and re-examination of the perfection of the spiral of a snail shell, the simplicity and aptness of the markings on the carapace of a crab, the grace of the plume of a feather-duster worm, the stark symmetry of a sea star, the texture of a beaver pelt, the subtle color shadings of a flower, and the myriad other things of beauty that we see, but must not mention, except in cold, academic verbiage.

SO the biologist keeps private—and even denies aloud—his aesthetic tangents, re-examines them only in the unobserved seclusion of his mind, and leaves it to such an unassailable colleague as the outstanding entomologist William Morton Wheeler to be spokesman for all. For, in speaking of what he referred to as the "dry rot" of academic biology, Dr. Wheeler said:

"We [biologists] should all be happier if we were less completely obsessed by problems and somewhat more accessible to the esthetic and emotional appeal of our materials, and it is doubtful whether, in the end, the growth of biological science would be appreciably retarded.

"It quite saddens me to think that when I cross the Styx, I may find myself among . . . many professional biologists . . . trying to solve problems, and that Pluto, or whoever is in charge down there now, may condemn me to sit forever trying to identify specimens from my own specific and generic diagnoses, while the amateur entomologists, who have not been damned professors, are permitted to roam at will among the fragrant asphodels of the Elysian meadows, netting gorgeous, ghostly butterflies until the end of time."

Thin-legged spider crabs may lurk on pilings in waters of both the tropics and subtropics.

Maroon mantle cavity of the flame scallop is bordered by tentacles of translucent white.

White-splashed indigo is the coloring of this symmetrically beautiful pelagic nudibranch.

Blue-and-gold sea slug is a benthonic nudibranch, which here lifts its head above the substrate.

Nondescript gray color
of an elbow crab
is an adaptation for
almost total invisibility.

Climatic complexity of Himalayas is reason for variety of vegetation zones.

At an altitude of 15,500 feet *Allardia glabra* bloom in Himalayas in October.

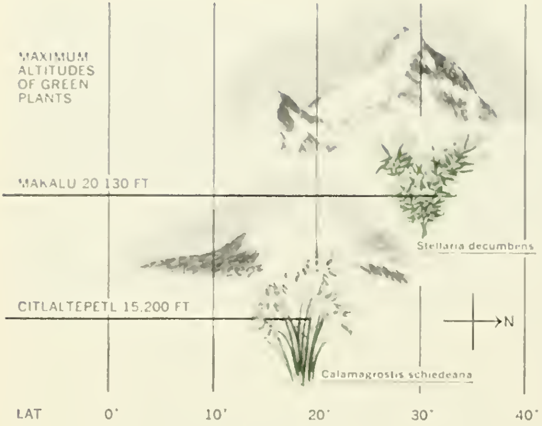
Ecology of the Heights

High peaks modify their own climate

By Lawrence W. Swan

Among the volcanic rocks and sand on the slopes of Citlaltépetl, the Aztec "star mountain," there are a few bunches of grass growing at an altitude of 15,200 feet. This plant species, *Calamagrostis schiedeana,* occupies the most elevated habitat for flowering plants in North America. Among the granite boulders on the northern slopes of Makalu, in the Himalayas, there are a few plants growing at an altitude of 20,100 feet. (One of these species, *Stellaria decumbens,* which was collected at 20,130 feet, probably represents the most elevated green plant on earth, see page 24.) Nearly a vertical mile separates these altitudes and the question arises as to why such a difference should exist. It is especially curious because Citlaltépetl, the Pico de Orizaba of the Mexicans, is due east of Mexico City at Lat. 19 degrees N., and Makalu is at Lat. 28 degrees N., a parallel that crosses southern Texas and is approximately 600 miles north of the Mexican peak.

It is well known that the snow line and its approximate equivalent, the "plant line," rise in altitude from the polar regions toward the Equator. On Mount McKinley, in Alaska, the highest flowering plants are found at 7,000 feet. On Mount Rainier, in Washington, the plants reach 11,000 feet, and on Mount Whitney, in California, the peak at 14,495 feet is apparently just below the line of permanent snow, and plants grow on the summit. An extension to Citlaltépetl at 15,200 feet and to the equatorial Andes at about 17,000 feet appears to verify the assumption of a rising snow line or plant line. Indeed, some of the atlases, geography texts, and ecological studies seem to make this inference, and they correlate latitude with the height of the snow line around the world. It seems logical, but it is not true. In the Bolivian Andes, far south of the Equator, plants ascend above 18,000 feet, and in Argentina, at Lat. 25 degrees S., they reach to nearly 19,000 feet. Beyond that the snow line and the plant line descend rapidly along the narrow-



ing maritime end of South America and reach sea level on the Antarctic continent much more abruptly than in northern Arctic regions.

It may be seen in the diagram on page 27 that the altitudinal extension of plants in the Andes is duplicated and exceeded in the Himalayan mountain system so that in the Karakoram Range, at Lat. 36 degrees N., equivalent to Mount Whitney, in California, plants grow at over 19,000 feet. It is apparent that the highest snow line and the highest extension of flowering plants are to be found some distance north and south of the Equator. The question arises again, why is this so?

The answer is obscure. There are undoubtedly many climatic and geographic conditions that cause the anomaly, but one inference seems most obvious: the Himalayas and the Andes are the largest mountain systems and their size must play an important role. The phenomenon of "mountain mass" is often mentioned as a factor that greatly influences climate, but explanations of this attribute are rather vague. Perhaps it may be better stated that the larger the mountain system, the less the mountains are affected by the prevailing temperatures of the latitude. A more detailed and meaningful answer is wanted, and a study of the high-altitude plants and climate in Mexico and the Himalayas may reveal one.

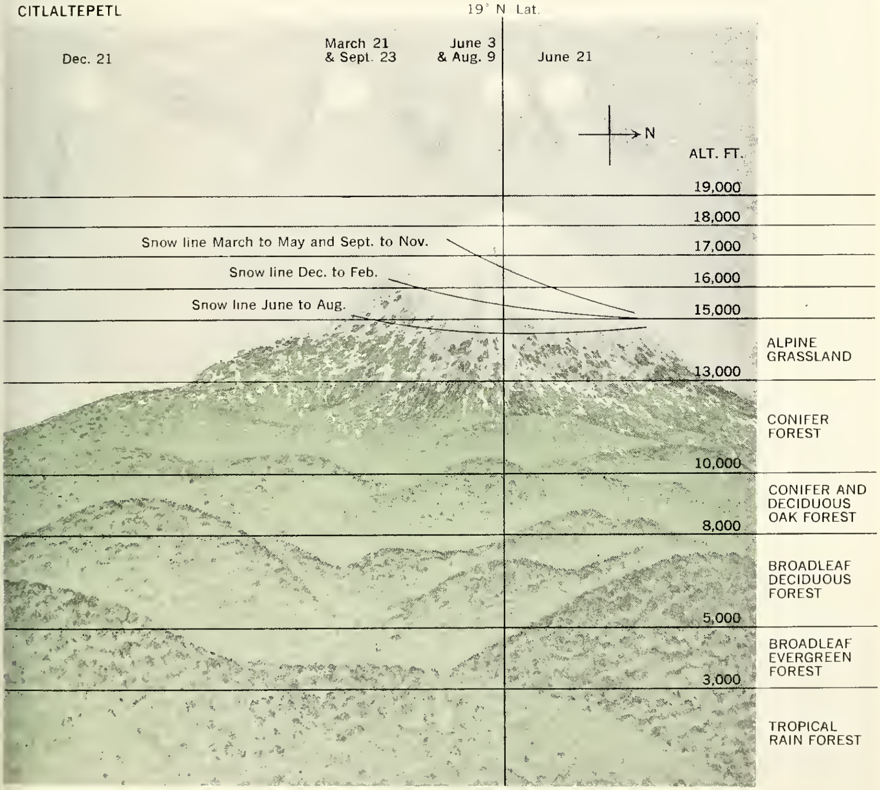
Citlaltépetl, rising to 18,701 feet, is the third highest mountain in North America. It is essentially an isolated peak overlooking the Gulf of Mexico. At Lat. 19 degrees N. the sun is overhead between June and August (see illustration on opposite page). In the spring and autumn months, when the southern slope is more directly exposed to the sun, the snow line assumes a striking, slanted appearance. It is above 17,000 feet on the south slope and below 15,000 feet on the north slope. One might expect the snow line to ascend on the north slope during the summer but it does not. In summer the wet ocean air condenses over the peak in massive clouds so that periods of sunshine are brief. Snow falls frequently and instead of a warming season during the summer there is an interruption of plant growth at the higher levels. On Citlaltépetl, as on most tropical mountains, the seasons are not well developed. There is no prolonged cold period followed by an extended warmer period, and snow may fall as low as the tree line in summer as well as in winter. Furthermore, Citlaltépetl, which was an active volcano in the sixteenth century, is covered with porous sand. Melting snow and rain water sink rapidly into the ground to emerge as springs along strata of impervious rock far down the mountain side. The whole alpine region of the mountain harbors only two small permanent streams, which emanate from the incipient glaciers of the northern slope. It seems that when the highest plants are not covered with snow they are without water. The mountain sets a handicap for the altitudinal distribution of plants, which can be estimated if the line that joins the plant limits of Canada and the United States is extended over Mexico (diagram, page 27). On this basis it would appear that Citlaltépetl should have plants at 17,000 feet at least.

In the Himalayas the factors elevating the snow line and plant line are perhaps more subtle. It is something of an enigma to view the Himalayas from the south, for the great vista of giant peaks is clad in snow and ice that descend to an altitude between 15,000 and 16,000 feet. If the Himalayas comprised no more than these southern peaks with their slopes exposed to the monsoon there would be few plants that could exceed 16,000 feet. There would be no elevated "hump" in the global plant line, for this altitude would conform with the North American and European extension of the plant line and almost compare to the deprivated upper slopes of Citlaltépetl. But the Himalayas have depth; beyond the first peaks there is another array of great mountains, and still another, until along the crestline, the massifs of Everest, Lhotse, Makalu, Cho Oyu, and Gyachung Kang create a wall that divides the atmosphere. In the foothills the rainfall may be 200 inches per year (in the Khasi Hills it sometimes reaches more than 900 inches!), whereas within 100 miles it drops below 20 inches. Behind the first snow peaks, in a space of perhaps 15 or 20 miles, the snow line ascends from 15,000 feet to over 20,000 feet (illustration on page 29).

It would appear that up to a point increasing aridity is an important factor influencing the snow line and the maximum altitudinal limits of flowering plants; and it is perhaps a characteristic of "depth" or "breadth" rather than simply "mass" that is most significant in creating a gradient of aridity. The inner valleys are not blanketed with snow, and plants can grow from early spring until the advent of winter. The sun shines even during the monsoon, which acts as an equable, moister phase in a long growing season. At higher altitudes the air temperatures are colder, especially at night, but the temperature difference between winter and summer seasons decreases. However, temperatures on ground surfaces in the sun may actually increase with altitude under some circumstances, and critical conditions for growth become more closely related to sun and wind than to shade air temperatures. The innermost Himalayas do not witness the grip of a continental winter, which bequeaths an extended icy aftermath into the spring months. At 20,000 feet in winter the air temperatures are probably milder than they are during an average winter in New York City. Snow disappears more rapidly at high altitudes; the greater intensity of the sun and the reduced atmospheric pressure cause it to sublimate as much as it melts. Dry winds from the great plateau of Tibet help sweep away the winter and monsoon snows and permit the hot sun to warm the ground, and there is also the general warming effect of the tropical ocean air of the monsoon. The air loses its enormous quantity of water vapor and gains heat from its condensation—a physical phenomenon that partly compensates for the loss of heat that accompanies the expansion of air as it rises over the mountains. In effect, one of the greatest masses of moving air meets the greatest physical obstacle on earth.

Nevertheless, in spite of the general aridity of the Tibetan borderland of the inner Himalayas, the highest peaks reach above their neighbors and catch the moisture of the highest stratum of the monsoon. They accumulate snow, and the glaciers and ice falls descending from these great snow fields reach downwards through the arid lands below the snow line to act as sources of water for plants and animals. Thus, small quantities of drainage water from snow are present in the highest Himalayas, but are absent on Citlaltépetl. When the altitude is 20,000 feet and the ground is not covered with ice, the existence of plants is governed by the availability of water. Despite a host of complex climatic differences that separate the Himalayas from Mexico, the final reason for plant survival at the highest altitudes in both areas may be essentially similar and applies, perhaps, to all mountains on which the snow line exceeds the upper limits of green plant growth.

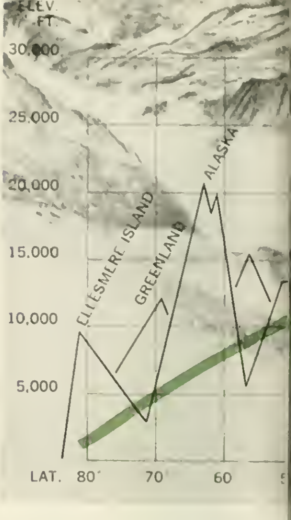
The brevity of a summer season between the remnants of one winter and the storms that precede the following cold season is an important limiting factor in the success of the alpine plants of northern temperate mountains. The short growing season of alpine North America, Europe, and Arc-


CITLALTEPETL
19° N Lat.
Dec. 21
March 21 & Sept. 23
June 3 & Aug. 9
June 21
N
ALT. FT.
19,000
18,000
Snow line March to May and Sept. to Nov.
17,000
Snow line Dec. to Feb.
16,000
Snow line June to Aug.
15,000
ALPINE GRASSLAND
13,000
CONIFER FOREST
10,000
CONIFER AND DECIDUOUS OAK FOREST
8,000
BROADLEAF DECIDUOUS FOREST
5,000
BROADLEAF EVERGREEN FOREST
3,000
TROPICAL RAIN FOREST

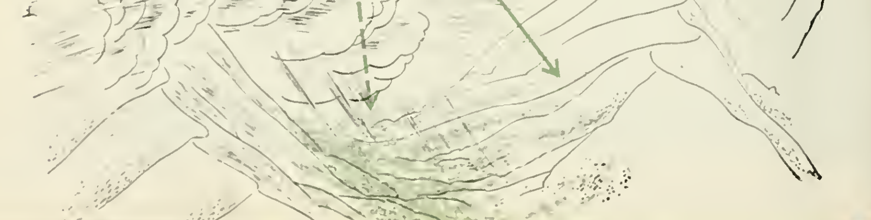
tic lands is an accepted ecological phenomenon, but it should not be considered as a characteristic of the alpine regions of the whole world. In the Himalayas, at 15,000 feet, plants may be found in bloom between the first week of April and the end of October, a period of about 200 days. Small gentians start the parade of flowers, followed by primulas; then fields of polygonums precede the flowers of dwarf rhododendrons. New groups of flowers succeed each other through the monsoon months. Summer primulas and the flowers of other moisture-loving plants bloom and disappear before September, only to be followed by a new burst of flowers in the October sun. Gentians of different species again lead this shorter autumnal "season," and on the edge of winter in late October, flowers such as those of *Ilardia glabra* are still fresh and attractive to insects. Above 20,000 feet, flowers of *Parrya lanuginosa*, *Pegaeophyton scapiflorum*, and *Gentiana urnula* bloom by May 27; on October 17 the umbels of *Selinum cortiodes*, and the blue-spurred flowers of *Delphinium brunonianum* are still intact at 18,000 feet. It is curious that some plants appear to respond directly to the environment, growing and flowering in accord with temperature and available water, whereas other plants, such as the various species of rhododendron, delay their flowering and hurry their period of fruiting as if they were growing on the mountains of North America or China.

The climatic peculiarities and intricacies of the Himalayas set the stage for a variety of vegetational zones. The lower slopes below 3,000 feet, essentially tropical, harbor plants of the lower monsoon forest that have many affinities with the vegetation of India. Between 3,000 and 8,000 feet or more, the middle and upper monsoon forests of evergreen trees have affinities with Burma and South China. Rhododendron and deciduous forests predominate between 8,000 and 10,000 feet, and above that the rhododendron trees and conifers form mixed forests up to tree line. These zones have affinities with West China (Sikang and Szechwan), as do the lower rhododendron-dominated portions of the alpine zone above the tree line. Throughout this wide altitudinal range, crops are raised, but extensive deforestation and widespread agriculture are primarily restricted to levels below 8,000 feet. It is surprising to find potato fields at 14,000 feet, and in places near Tibet a few crops, such as turnips, are grown at 16,000 feet.

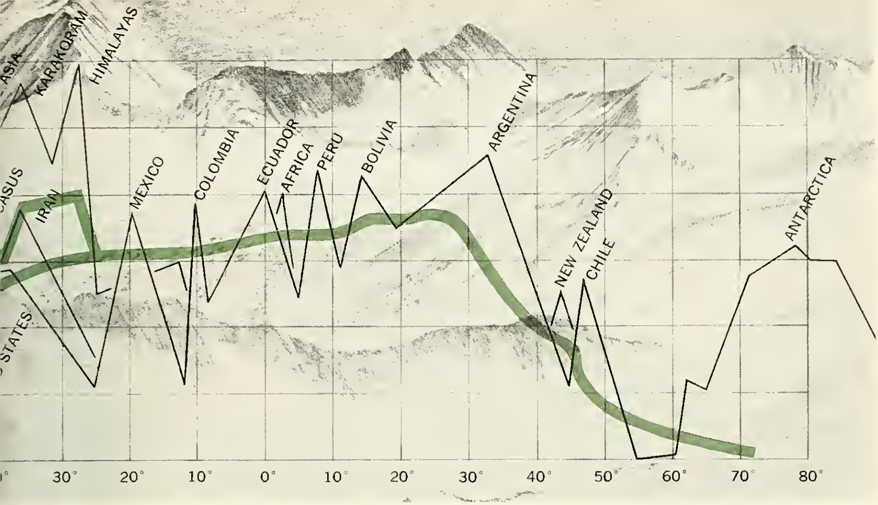
THE alpine zone extends from the limit of trees in the vicinity of 13,000 feet to over 20,000 feet, at the level of the highest green plants. It is the most extensive alpine region in the world. It is peculiarly complex, and whereas many alpine zones may be subdivided into various community categories, the eastern Himalayan alpine zone can be divided into major belts of vegetation. In the western Himalayas birch trees extend above the conifers to form a subalpine zone of trees, but in the eastern Himalayas the firs *(Abies spectabilis)* match the birch trees in altitude, and a new, distinct shrub zone—truly alpine in



nature—develops above the trees. Thickets, composed primarily of bushes of *Rhododendron campanulatum* less than 6 feet high, cover the slopes for perhaps 500 feet above the trees and then give way to a distinct and dominating growth of dwarf rhododendron (*R. anthopogon* and *R. setosum*) and junipers scarcely a foot high. *Rhododendron anthopogon* may be found as low as 12,000 feet and above 17,000 feet, but its primary level lies between 11,000 and 15,000 feet. Above the major growths of dwarf shrubs there develops a zone of cush-



TEMPERATURES on the ground surfaces in the sun may increase with altitude, and growth is related to sun and wind.



HIGHEST extensions of flowering plants (green line) are some distance north and south of the Equator. In the Karakoram Range of the Himalayas, plants grow at over 19,000 feet, and in Argentina they ascend to about the same altitude.

ion and prostrate plants mixed with low grasses and sedges. This zone can be noted at 15.000 feet and may extend in favored spots to over 19,000 feet. It exists at too high a level to appear on the southern exposure of the mountains where the snow line meets directly with the dwarf shrub formation. Toward Tibet it alters into a related desert vegetation of scattered prostrate plants. This zone of cushion and prostrate plants of the Himalayan alpine region contains many Arctic plants and species related to northern Eurasia, and it is akin to the typical tundra areas of the far north.

ABOVE the zone of cushions, plants are virtually confined to the bases of rocks. This form of growth is actually widespread, and its incipient beginnings can be noted at much lower elevations. But on the dry scree slopes above 18,000 feet, a discrete zone develops where, except for occasional mats of plants growing on flat, sandy areas where snow drainage water has accumulated, the only green plants are the scattered and hidden growths at the bases of rocks. It appears that some plants may be entirely restricted to this highest level, where snow sublimates rapidly and water, if it forms, is available only beneath the surface. The exposed rocks are heated by the hot sun, and if the occasional temporary snow is present some water from melting drips down to be trapped by the rock base before it evaporates. Without snow the rock surface is too dry to support visible lichens. The rock bases also trap quantities of wind-blown organic debris as well as seeds, and in this way the potentialities for growth are enhanced.

Beyond the rock base plants, in those areas where permanent snow is not found, insects such as springtails still survive. Presumably they feed entirely upon wind-blown organic debris. Salticid spiders feed on the springtails, and together with bacteria, fungi, and other simple living things another biome, which is distinct from the alpine, can be recognized. This is the aeolian zone. It can be conceived at its widest extension in the Himalayas, but with variations it can perhaps be extended to include most mountain ranges with permanent snow, as well as the polar regions. The aeolian zone is based on wind-blown debris, and whenever green plants are not in evidence the scavenging insects and saprophytic plants can be considered as part of the aeolian system. Machilid thysanurans (glacier fleas), existing on the barren rubble covering the glacier, fit into this category as do the phyllopod crustaceans and midges that live in the dirty pools of water that collect on the glacier. Indeed, the huge populations of stoneflies and mayflies that swarm in glacial torrents as they emerge from the ice would appear to depend on the organic debris of the glacier, which had its origins as wind-blown matter. The algal growths that color the snow must also rely on this debris for essential nitrates. The algae bring green plants into the aeolian circle of life and also further unite the aeolian zones of mountains and poles. It appears that the Himalayas exaggerate the high zones of life and, by magnification, permit identification of this new zone. Its integrity in the Himalayas can perhaps support its distinction as a separate and widespread phenomenon in all the frigid portions of the earth's surface.

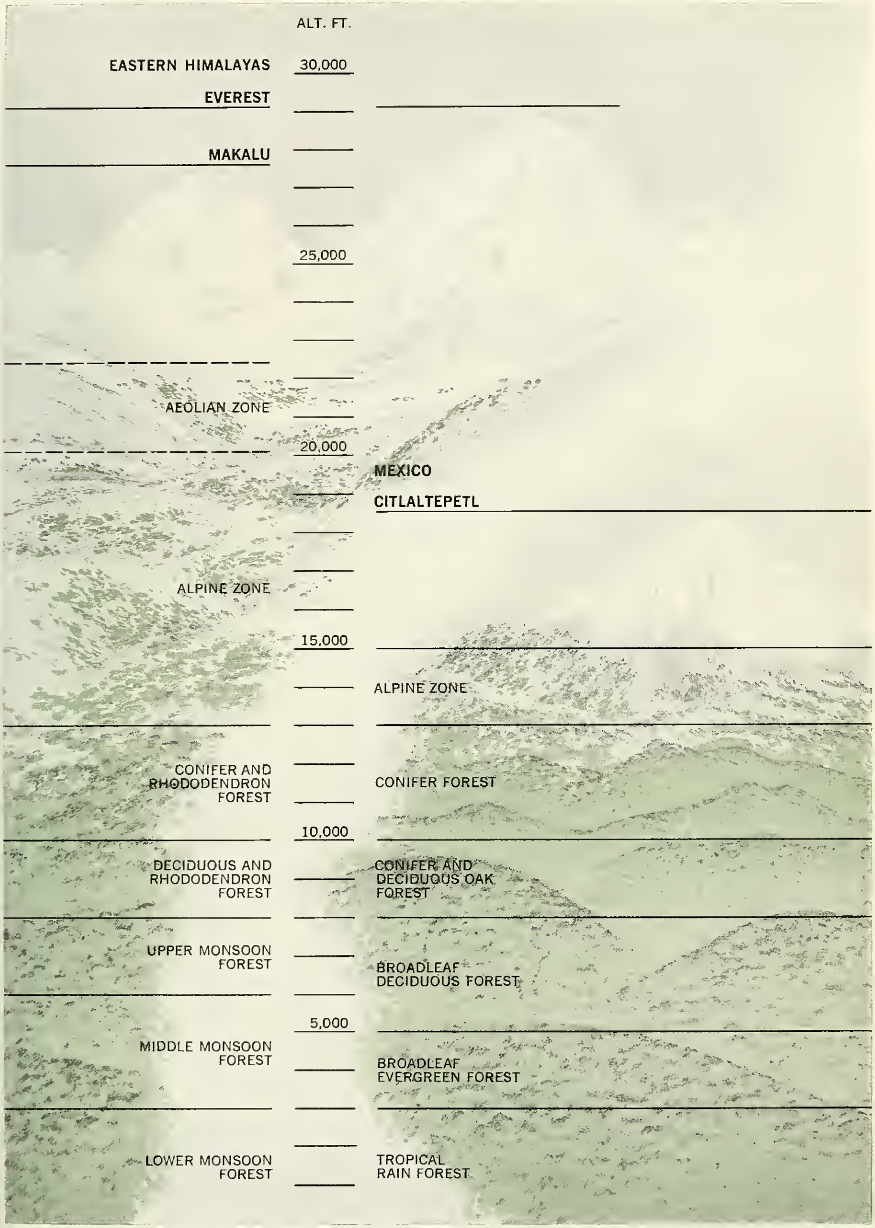
The most striking differences between the appearance of vegetation on Citlaltépetl and on the Himalayas near Makalu are found in the alpine zone. It is as if a host of climatic factors combine and are operative above tree line, for instead of 7,000 feet of alpine vegetation with the many alpine subdivisions of the eastern Himalayas, the Mexican slope above tree line is a brief 2.000 feet of grassy fields. Many minor plant communities based on soil, exposure, and moisture do develop, but the whole formation is scarcely equivalent to the Himalayan zone of dwarf rhododendrons. The highest grasses, together with a few plants such as the Indian paint brush (*Castilleja* sp.), do assume a rock base type of growth, but the brevity and local character of this form of protection at the highest level can hardly be compared with the protracted and discrete zone of rock base plants in the Himalayas. At slightly lower elevations some Mexican plants hide at the base of the hardier grasses and, in general, the way some plants utilize other hardier plants for protection or for better moisture or soil condition is far more evident on Citlaltepetl.

THE tree line in the eastern Himalayas extends to 13,500 feet on favored slopes of the inner Himalayan valleys, but remains near 12,000 feet near the summit of exposed ridges. On Citlaltépetl the altitude of tree line is virtually identical and stresses above all other vegetational features that the Himalayan-Mexican climatic differences accrue above this level. It suggests again that the clouds that tower over the peak above the line of trees—a distinctive feature of the summer months—are the primary mediators of the alpine biome. Furthermore, if it were simply a matter of the lesser "mountain mass" of Citlaltépetl, it would seem that the total range of vegetation would be condensed and similarly abbreviated. A comparison of the vegetation belts below tree line on Citlaltépetl and the eastern Himalayas indicates, with the exception of the peculiar rhododendron flora of the Himalayas, a remarkable similarity in the general types of vegetation and their altitudinal distribution (drawing, opposite page). The highest trees on Citlaltépetl are pure stands of conifers (*Pinus hartwegii*), which mix with firs and spruces at roughly 11,500 feet. At about 10,000 feet deciduous trees such as oaks are evident in the conifer forest and in some places replace it entirely. Below 8,000 feet cultivation is extensive and cornfields predominate until the level of the plateau is reached. On the eastern slopes the mountain sweeps down into the wet tropical forests of Vera Cruz and in a single day of walking one can leave the equivalent of Arctic snow, pass through the Hudsonian and Canadian types of forests until, with the sight of robins in the cornfields, one is reminded of the midwestern United States. Lower down, broadleaf evergreen trees with epiphytes replace the deciduous trees, and the land is reminiscent of the warm temperate forests of Louisiana and northern Florida. Shortly below 3,000 feet, heavy lianas and strange trees introduce the tropics. But here the tropical mammals and birds are related to South America. Various species of parrots scream a reminder that a crossing has been made from the Nearctic into the Neotropical region. In the Himalayas, perhaps the only other place on the earth where altitude similarly separates two major zoogeographical regions, the transition is made between the Palearctic and the Oriental regions. However, it is doubtful whether the altitudinal changes in any mountain range are as abrupt and dramatic as they are on the great eastern slope of Citlaltépetl. It is one of the most fascinating biological areas on earth, and it is surprising that only a handful of biologists has seen this spectacular region and that probably none has studied it in detail.

In summary, it may be inferred that the alpine zones of the mountains of the world differ in their basic climatic characteristics. There are perhaps three major types: (A) equatorial alpine regions as evidenced by tropical mountains and, in part, by isolated peaks such as Citlaltépetl; (B) low-latitude alpine regions as found in the Himalayas and the Andes; and (C) the high-latitude alpine regions such as those of North America and Eurasia. The latter merge with the Arctic regions and carry with them many of the seasonal and biotic characteristics of the polar areas. These alpine regions have been studied most extensively and the concept of alpine life has mirrored this research. Indeed, the term "tundra," with its Arctic connotations, may be suitable for high-latitude mountains, but it is less appropriate when it encompasses the whole alpine biome as the tropics are approached.

In the tropics seasonal differences in climate are reduced. Snow falls at relatively low altitudes throughout the year, and it is not possible for flowering plants to develop at the highest levels. The snow does not recede for a long enough season to permit successful growth, and above 15,000 or 16,000 feet it is as if there were but one prolonged mild season—a winter season. The high-latitude mountains of Europe and America experience long, severe winters that leave a heavy blanket of snow, which, by its delayed melting, reduces the growing season for plants at the highest levels. The growth of plants reflects the heavy blankets of snow, and forms such as the *Krummholz*—the elfin timber at tree line—epitomize the northern alpine regions, but are exceptional at lower latitudes. The short season during which moisture is generally available from melting snow also promotes the growth of lichens, and these plants are abundant at the highest levels in northern alpine regions. They are scarcely evident at high levels in the dry alpine zones of low-latitude mountains. In the low-latitude mountains exemplified by the Himalayas heavy precipitation on the slopes exposed to the monsoon acts to reduce the level of plant growth in a manner that is characteristic of more northern mountains. However, the inner, sheltered valleys receive less snow and, being at a higher altitude, the increased effects of insolation and sublimation raise the snow line to very high altitudes. Furthermore, at these altitudes the winters are not severe. Without snow the soil is warmed, and the growing season is hastened in spring and prolonged in the autumn. Instead of a single, brief growing season there are perhaps three phases of a long growing period. Water availability becomes critical as the highest levels are approached, and at 20,100 feet—in the absence of permanent snow—evaporation, sublimation, and limited sources of moisture are determining factors in growth.

ZONES of vegetation become extended and amplified in the wide alpine zone of the Himalayas. On a tropical peak such as Citlaltépetl the alpine zone is simple and less than a third in altitudinal extent. However, the tree lines of the two areas coincide remarkably, and below the alpine zone there is a broad similarity. From this fact it would appear that the climatic factors that determine the height of the snow line and restrict the upper limit of plants operate primarily in the alpine zone, and except on some truly equatorial peaks do not involve the lower levels of the mountains. These climatic factors are related more directly to local cloudiness, aridity, length of season, and insolation than to the prevailing climate of the latitude at sea level. It is curious how high mountains influence and modify their own climate to the extent that assumptions made on the plains are not appropriate when applied to the high lands of thin air that lie considerably closer to the sun.


ALT. FT.
EASTERN HIMALAYAS
30,000
EVEREST
MAKALU
25,000
AEOLIAN ZONE
20,000
MEXICO
CITLALTEPETL
ALPINE ZONE
15,000
ALPINE ZONE
CONIFER AND RHODODENDRON FOREST
CONIFER FOREST
10,000
DECIDUOUS AND RHODODENDRON FOREST
CONIFER AND DECIDUOUS OAK FOREST
UPPER MONSOON FOREST
BROADLEAF DECIDUOUS FOREST
5,000
MIDDLE MONSOON FOREST
BROADLEAF EVERGREEN FOREST
LOWER MONSOON FOREST
TROPICAL RAIN FOREST

TYPICAL mantis pose has given it the name Devil's Rearhorse in some areas.

Beneficent Cannibalism

Praying mantis aids in control of insects

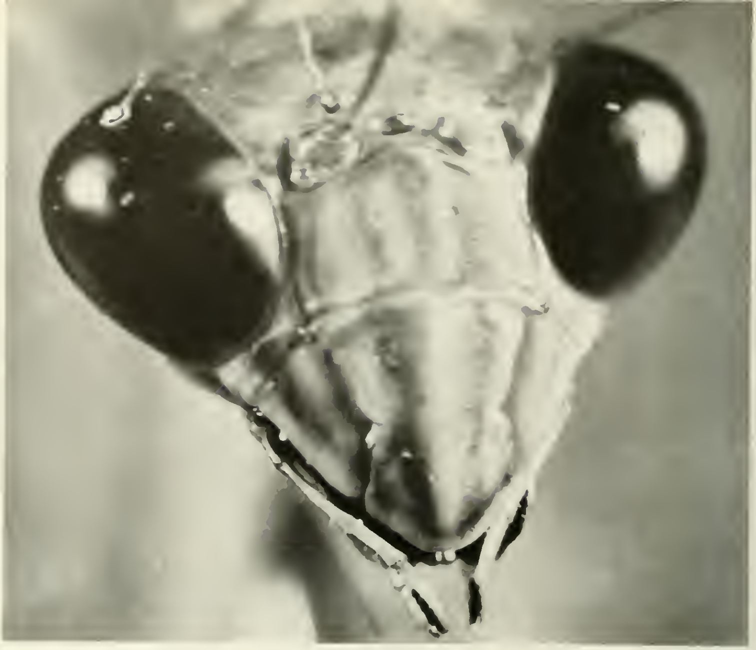
By EDWIN WAY TEALE

IT MAKES NO SOUND; it is voiceless. It turns its pointed face this way and that; it is the only insect that can turn its head like a man. It merges with the foliage of its background; its body is camouflaged in greens and browns. It remains for long periods with forearms uplifted as though in supplication; it is thus that it awaits the approach of its victims. This creature of curious attributes is the praying mantis, known in various localities as the Southsayer, the Nun, or the Devil's Rearhorse.

The winged adult insects, almost as long as your hand, seem to make their appearance suddenly late in summer. Many people think they have come as a flock of migrants. In truth, they have been here all the time. So well camouflaged is the mantis, so silent its ways, that it is rarely noticed until it reaches its full size, develops wings, and begins to fly about. The males, slenderer and more active than the females, sometimes rise high in the air and cover considerable distances. Nearly a hundred of these insects, in a single week, landed on the observation tower of the world's tallest structure—the Empire State Building in New York City.

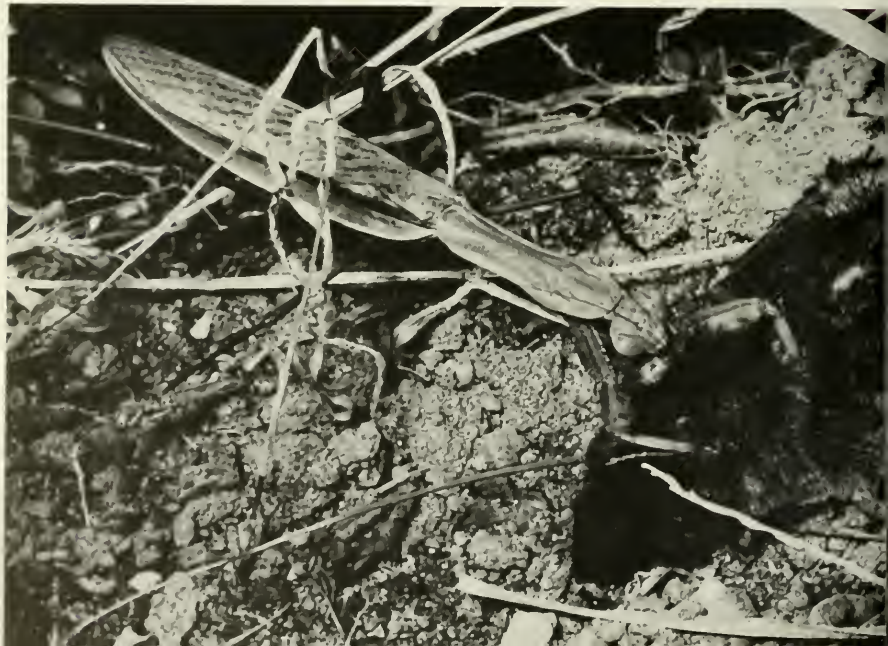
In the United States there are four species of praying mantises. One, *Stagmomantis carolina*, is native and is found thoughout the South and as far west as California. *Mantis religiosa*, the European mantis, reached our shores from France about the time of the Spanish-American War. It probably came in the form of an egg case

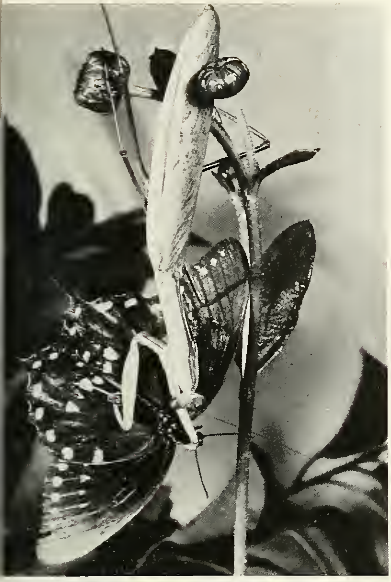
SPINED FORELEGS of the adult insect are used to catch and hold various victims.



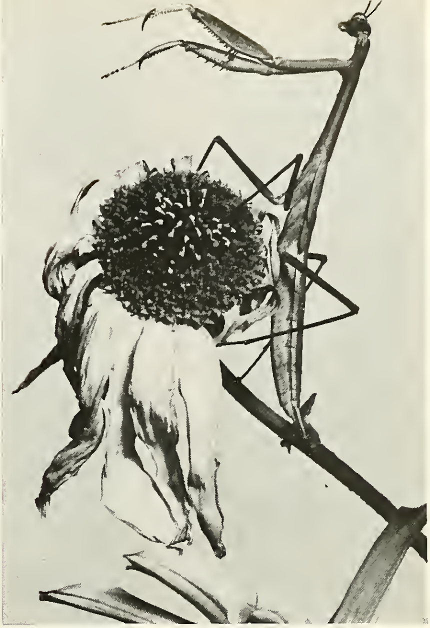
COMPOUND EYES and strong mandibles make mantis formidable foe to insects.

STILL-WARM SHREW, perhaps dropped by a cat, is attacked on neck by mantis.

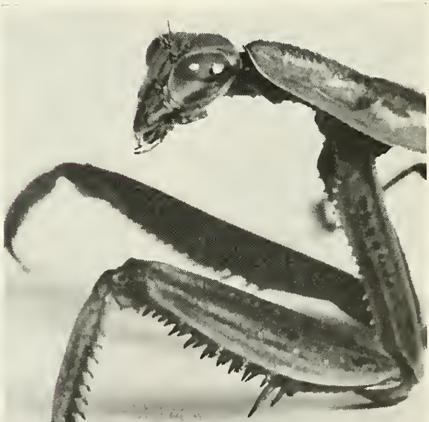




Swallowtail butterfly is seized by mantis, which is as long as human hand.



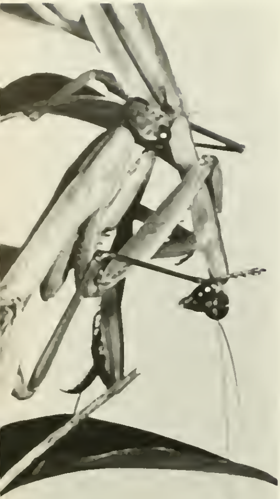
Green-and-brown coloration permits high degree of camouflage in foliage.



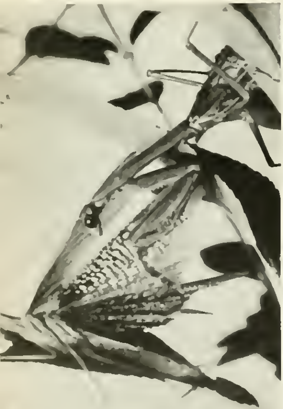
Voiceless mantis is the only insect able to turn its head in manner of man.

attached to packing material used to protect nursery stock, and made its first appearance in a nursery near Rochester, New York. At almost the same time another immigrant insect, the Oriental mantis, *Tenodera sinensis*, appeared on shrubs in another nursery near Philadelphia, Pennsylvania. It had come from China. A fourth species, *Tenodera angustipennis*, also Oriental, was found later in the Philadelphia region. This latter species has narrower wings than *T. sinensis* and produces an egg case that is entirely different in its form.

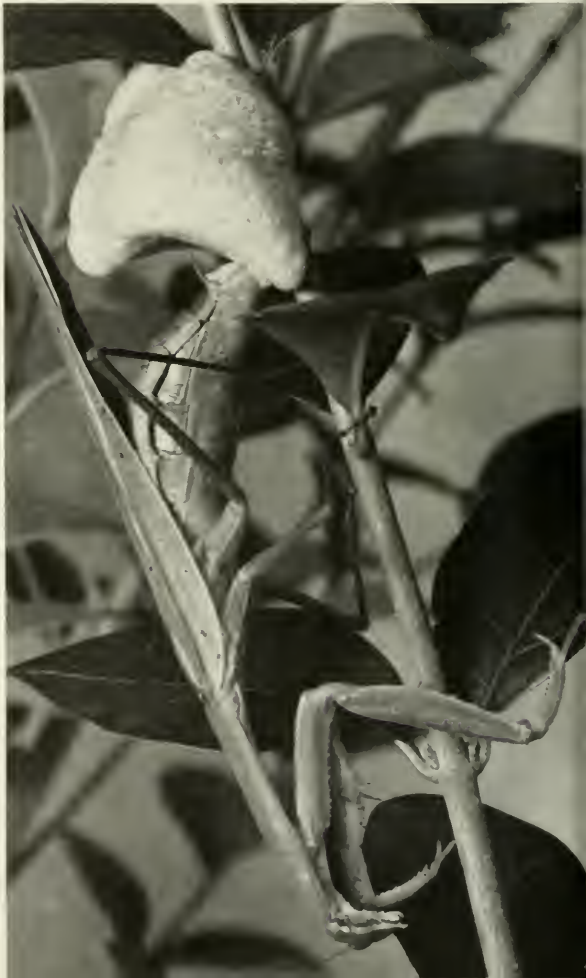
THE European mantis has worked its way west and north across the Canadian line and now is established in southern Ontario. The original Oriental mantis, *T. sinensis*, is common through New Jersey and southern New York and has found its way to Ohio and other states beyond the Alleghenies. The second Oriental species, *T. angustipennis*, is also increasing its range. By 1944 it had reached Long Island. In the spring of that year I found the first *T. angustipennis* egg cases to be reported from that area. They were attached to twigs on a wild



MATING ends in cannibalism as female imprisons male and begins to bite neck.



DECAPITATED males often are able to move; sometimes they even try to fly.



FEMALE hangs head down from a twig and produces an egg-filled froth case.

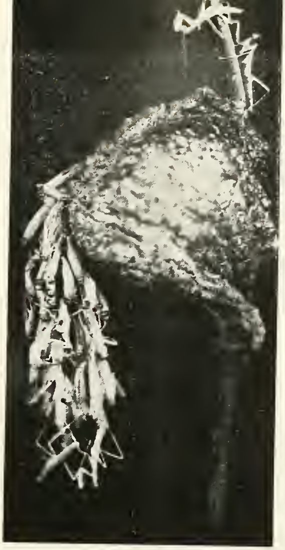
cherry tree near the town of Baldwin.

The praying mantises have voracious appetites for insect prey and are virtually the only insects introduced accidentally into America that have proved beneficial to agriculture. A mantis will attack anything within reach that moves. Its main diet consists of a succession of beetles, bugs, caterpillars, and other insects. But it will catch a hornet or a bumblebee just as readily as it will a squash bug or a housefly. I have found a mantis with a captured swallowtail butterfly and another with a large green darner dragonfly. There are records of these predatory insects capturing hummingbirds, Cecropia moths, mice, and De Kay garter snakes. I once watched an immature mantis, hardly two inches long, attack a full-grown tomato worm twenty times its bulk. Although it was unable to hold its prey, it put it to flight. A mantis will rear and box with a kitten or hold its own with a pugnacious English sparrow, yet it is completely harmless to man.

Each autumn, when the full-grown insects begin to appear in the region of New York City, such institutions as the Bronx Zoo and The American Museum of Natural History receive a flood of inquiries. They come in by telephone and by mail. The inquirers want to know what the strange insect with the spiked forelegs is and whether it is dangerous or not. Few other insects attract as much attention.

In Times Square, a mantis reared up on a fireplug always is surrounded by a crowd of curious spectators. In a middle western city, a few years ago, traffic stopped on a main street while the motorists watched a pitched battle between a sparrow and a mantis. The sparrow, incidentally, was the one that first gave ground. In the house, a mantis makes a docile pet. It will eat proffered insects and even bits of corned beef or hamburgers, and will remain in one position on a plant for hours at a time. In at least one large biological laboratory, the praying mantis is substituting for the guinea pig as the subject in various tests.

The story and life habits of all the species of these insects are much the same. That of the commonest mantis of the eastern United States, *T. sinensis*, begins in the warmth of the late spring. All winter the rounded, walnut-sized egg case has remained attached to a twig or weed stem.

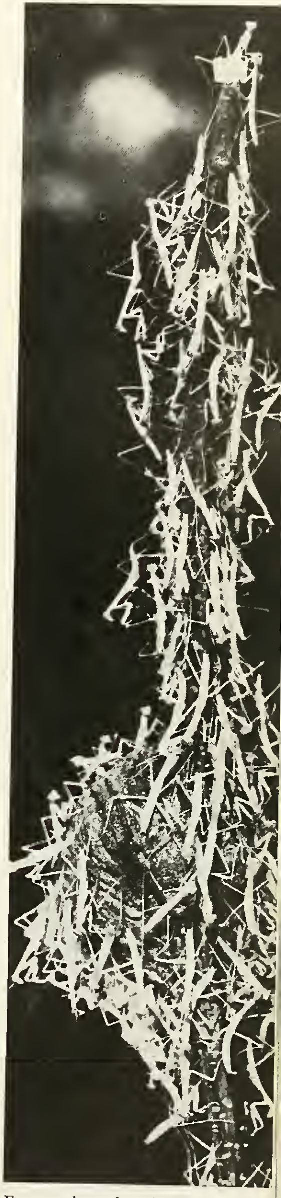


In late spring, young in membranous shells emerge from the softened cases.

This marvelously wrought mass of hardened froth was produced by the female of a previous generation and attached, the autumn before, to its present support. In a central compartment, enclosed within a tough wall, are the elongated eggs. From 125 to 300 of them are ranged together like cordwood within each egg case.

The hazards of winter are numerous. Sometimes mice gnaw into the egg cases and reach the central compartment. Sometimes woodpeckers drive their chisel bills into them and consume the eggs inside. Sometimes grass fires consume the weeds to which the cases are attached. But in spite of these hazards, most of the egg cases survive until spring. As the warmer days lengthen, the balls of hardened froth become softer and more spongy. Then one morning, usually between eight and ten o'clock, hatching begins.

Down the front of each egg case is a narrow strip of overlapping plates, suggesting a vertical row of tiles placed one above the other, between which the hatching insects wriggle out. Each is honey yellow and is enclosed in a membranous sac. Dangling head downward from a silken thread, which extends from the rear of the sac into the interior of the egg case, the insect pushes and struggles from time to



Freeing themselves from their shells young mantises crawl up vertical twig time. Around it are scores and sometimes hundreds of other young mantises dangling in exactly the same manner. It is at this time that the praying mantis passes through one of its most dangerous periods. The newly hatched insects are soft, defenseless, and vulnerable to attack, particularly by ants and birds. When the mantis works free from the sac, it climbs to the top of the egg case or onto the supporting twig. Here its chitin shell hardens and darkens, and a quarter of an hour later its honey yellow has changed to light brown.

EACH mantis searches for its own food and should one of its kind come within reach of its spiked forelegs, it snaps at it as quickly as at any other prey. When an egg case hatches within a closed cage, the number of young insects rapidly decreases through cannibalism. Probably the first food of these hunting insects are plant lice and similar six-legged minutiae. As the mantis grows larger by successive molts, it takes on larger and larger prey, which it always captures in the same manner. With its folded forelegs lifted, it remains motionless among the leaves — or moves cautiously forward like a stalking cat —until its victim is within reach. Then the forelegs, with the spikes facing each other, clamp shut over the back of the prey, which is imprisoned as though in a toothed steel trap. Whether it has caught a wasp, a butterfly, or a grasshopper, it begins by biting into the back of the insect's neck, quickly severing the main nerve ganglia. Once I came upon a praying mantis with a shrew gripped in its forelegs. The shrew may have been dropped by a cat or it may have been captured by the mantis. At any rate, its body was still warm, and the mantis was attacking this huge and abnormal victim just as it would attack a fly or a bee—by biting its way into the back of the animal's neck.

IN AUTUMN, after the final molt, gauzy wings appear and insect is full-grown.

Nothing seems to affect the digestive systems of these predators. They have eaten green paint, daubed on insects for purposes of identification. They have devoured insects that have been taken directly from ammonia, from cyanide killing jars, from wood alcohol. I have seen a mantis eating the spiny hairs of a caterpillar.

In the region of New York City, the insect is ready for its final molt by the end of August. At that time, its slender, gauzy wings appear and it is full-grown. In the air, it flies on its four fluttering wings with its neck outstretched in the manner of a wild goose. Favorite hunting spots of these insects are butterfly bushes, goldenrod clusters, and wild cherry trees — especially when they form bushy clumps a few feet high.

Indian summer finds the life of the adult mantis in its concluding weeks. It is in the autumn that mating, and that strange feast that often follows it, takes place. The female devours the male, sometimes in the midst of the mating. In fact, one female may devour more than one male, and Fabre cites an instance in which a female mantis consumed eight of her suitors. The males are more active than the females; they can easily escape; yet they hardly struggle.

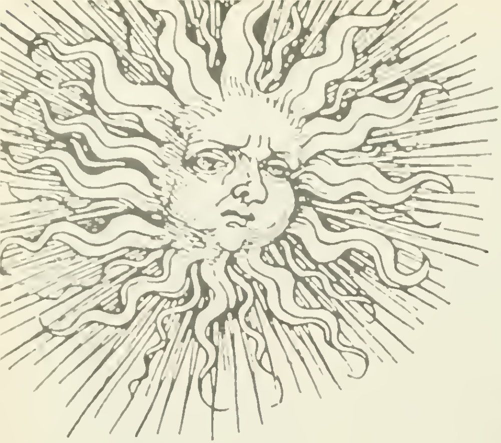
THE female begins by clamping her forelegs over the back of the male and biting through the armor on the back of his neck. Even after the male is headless, he can raise his wings, walk, and even attempt to fly. It is an eerie sight to observe a decapitated insect lift its wings or, as it is falling through the air, reach out with a leg and catch a branch and then pull itself up on this support. The nerve centers of the mantis are located in various parts of its body; the unaffected ones go on functioning even after the head is gone.

The female mantis, hanging head downward from a twig or stem, produces one or more froth cases packed with eggs, a process that may take the better part of two hours. White, frothy material appears from the tip of her tail and is carefully worked around the foundation. Then the tip of the tail begins moving slowly, in a gradually expanding circle, building up the mass of froth. When most of the froth is in position and has been formed into the desired shape, the tail pauses, moves to the center of the foam mass, buries itself there, and for a time changes its position but little. Then starts a pumping motion, which produces rhythmical pulsations along the insect's abdomen. The eggs are being placed within the ball of froth. Next the tip of the tail begins its slow revolutions again, building up the bottom of the case. When completed, the froth is sticky and resembles the beaten white of an egg. As days go by, the white of the egg case darkens to yellow, then to brown. It becomes tough and the wall of the inner compartment, within which the eggs are housed, takes on a leathery hardness. In midwinter, a safety razor blade will hardly cut it.

TO the attacks of one curious little enemy, which preys on some species of mantises, *T. sinensis* appears to be immune. This parasite hides beneath the base of the wing of a female mantis until case-making begins, then creeps backward along the larger insect's abdomen until it comes to the very tip of the tail. Here it clings, and when the pumping motion begins the insect deposits its own almost invisible eggs on those of the mantis. Within the case, the parasites hatch and feed on the larger eggs.

With the end of the mating season, and the completion of the egg cases, the climax of life is over for the praying mantis. In northern states, it is a creature of a single summer. The end of warm weather is the end of its adult life. Even when a mantis is brought indoors and fed on plump crickets and other fare, even when it is kept warmed day and night, it lives only a few days —or weeks at most—beyond the span of what would be its normal existence.

MANTIS is among very few introduced insects that actually aid agriculture.

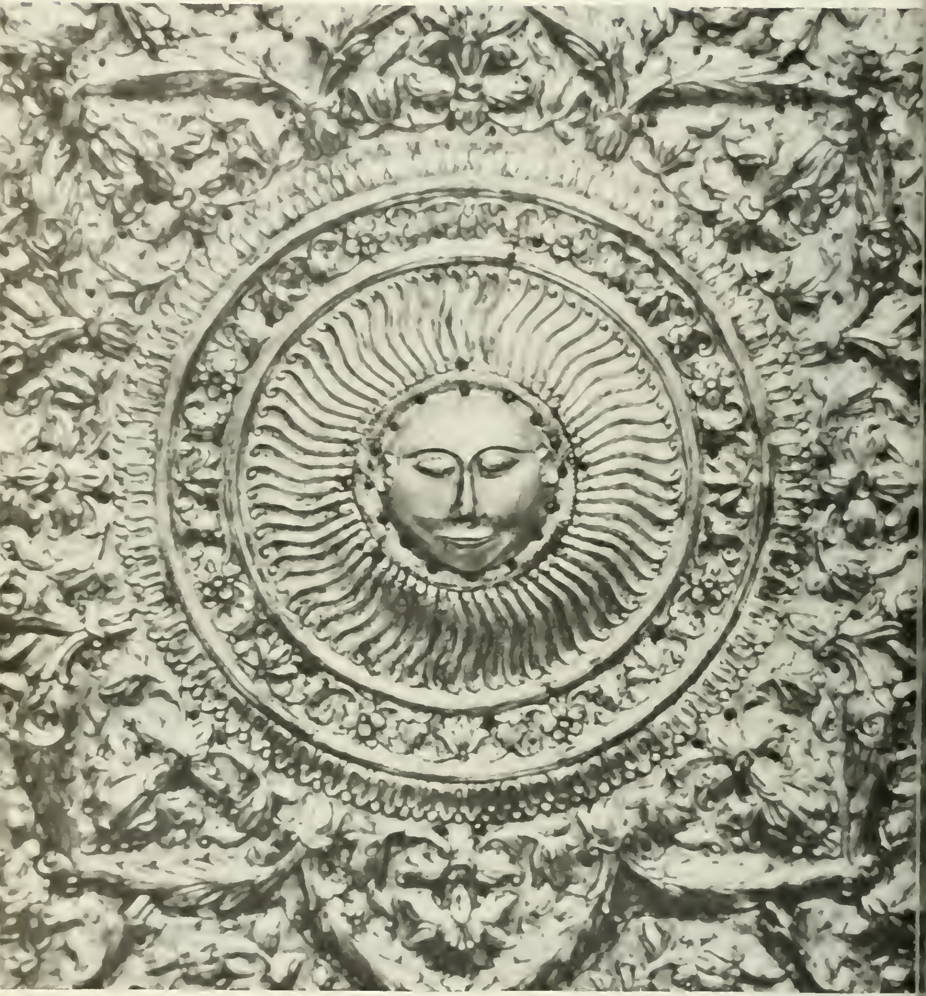


Albrecht Dürer depicted the sun, at left, in his woodcut of the Apocalypse. That at the right is keystone of an arch of Berne Minster.

Man has busied mind and hand with the sun over the millenniums; he has carved and incised it in stone, has chased and hammered and engraved it in metal, has cut it in wood, has drawn and painted it on rocks, on parchment, paper, and canvas. He has made it a god, has worshiped it as the embodiment of natural and supernatural powers, has given it a place in every sphere of his earthly activity. At all times, under all skies, the profound relationship of man and sun has persisted, and is still giving birth to new symbols, new images. . . .
These are the words of Walter Herdeg of Graphis Press, Zurich, Switzerland, which recently published the handsome and unusual book entitled *The Sun in Art*, available directly from the Press. Through Mr. Herdeg's generous co-operation, NATURAL HISTORY is able to present on these pages some of the text and illustrations that appear in the book.

the sun

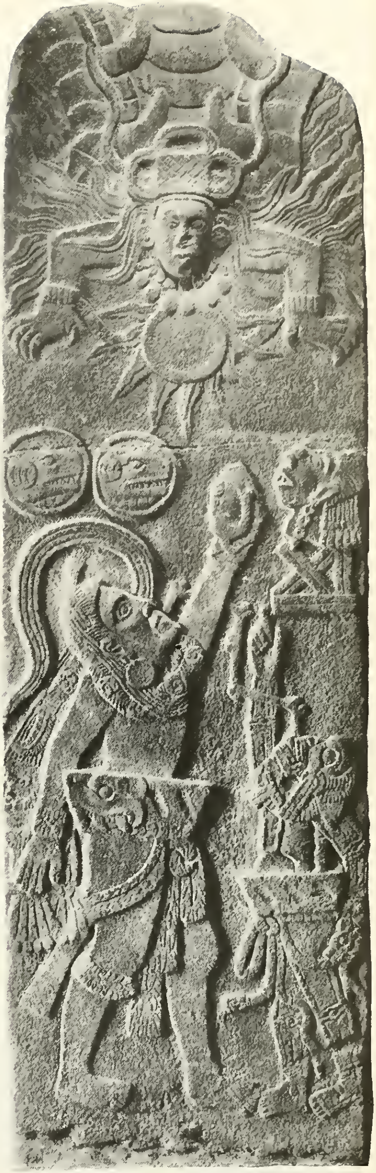
Solar symbols girdle the worl



Buddhist depiction of sun is part of the golden ceiling in the Golden Temple at Amritsar, India.

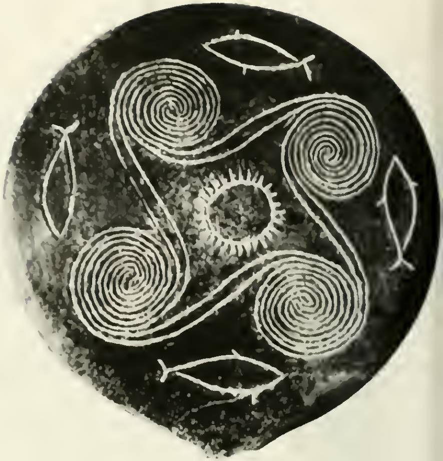
Underside of an Etruscan oil lamp
possibly of 7th century B.C.,
shows sun and mythological symb

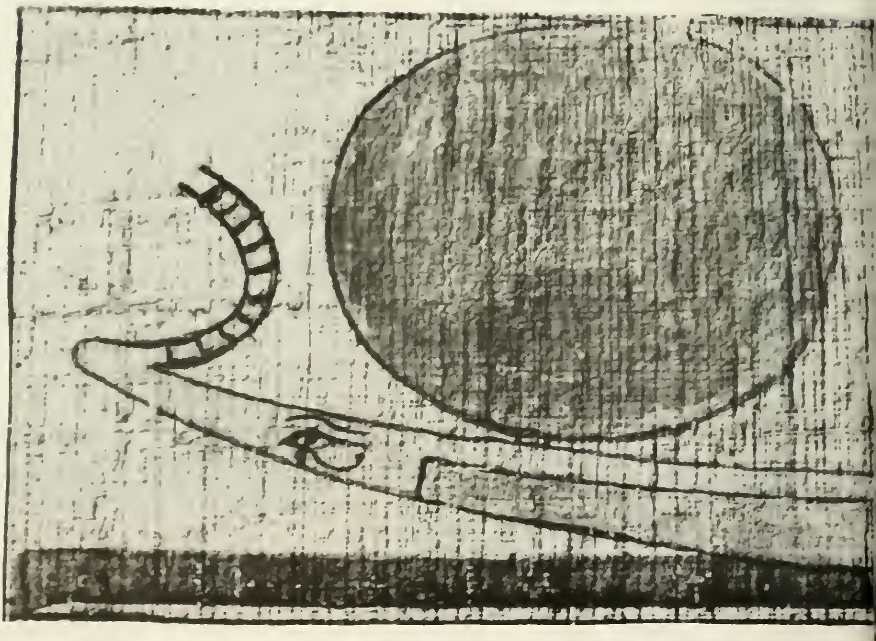
The capacity of the sun emblem for graphic metamorphosis seems unlimited. According to the needs of the draftsman, it is now a circle, now a spiral or a wheel; it merges with the eye, with a wing or a sickle-shaped horn; it takes on the form of objects and beasts, is a boat or a carriage, a dragon, a fish, or a bird. For being the chief source of the earth's and man's energy, the sun is not necessarily beneficent but may equally well embody forces of destruction, as exemplified by drought and desert, by the pests and endemic diseases of sunny climates. It is precisely this duality of the sun, its ambiguous nature of light and darkness, that predestined it from the earliest times for the role of a godhead: for how should a god be worthy of the name if it is not capable of inspiring fear? Christianity and European mysticism have, in the course of a laborious process of assimilation, transformed the old sun cult and the worship of the lights of the heavens into a spiritual experience. The halo, the gloriole, are no longer solar symbols, but the expression of a luminous vision of light, and as such are not merely external but also indicate an inner energy, a fount of life.



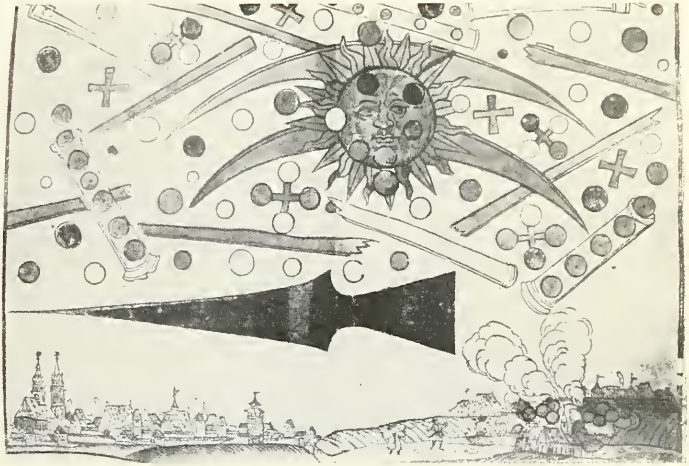
Upper portion of Guatemalan stela dramatizes sun god; the lower part may be sacrificial scene.

The oldest proofs of the close connection between sun worship and fertility, sun and kingship are furnished by the ancient hieratic city of Heliopolis in Upper Egypt, which flourished from the fifth dynasty onward (*ca.* 2580 B.C.). Here the belief arose that the royal line was descended from the sun god Re or Ra, that the living Pharaoh was identical with Horus, the late-born son of Osiris. The huge stone pointers we know as the pyramids are not merely burial sites but solar monuments, astral sanctuaries, with which the Pharaohs remonstrated against the ideas of transcience. And long before the great solar cultures we find the monogram of the sun inscribed in the rock caves of prehistoric Spain and France. Light is only perceived against darkness, and we are accordingly not surprised to find the earliest sun-signs in gloomy underground passages and shadowy rock shelters. Here for the first time we discover the disk with emerging rays, perhaps an attempt to capture the sun and to take possession of it.



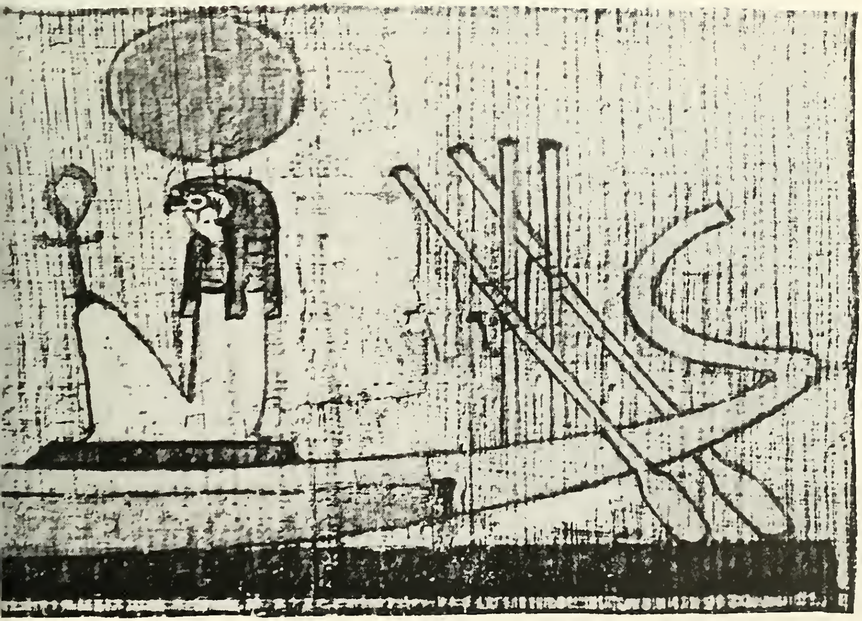


Sun surrounded by strange celestial phenomena, at right, is from a broadsheet of the 16th century.

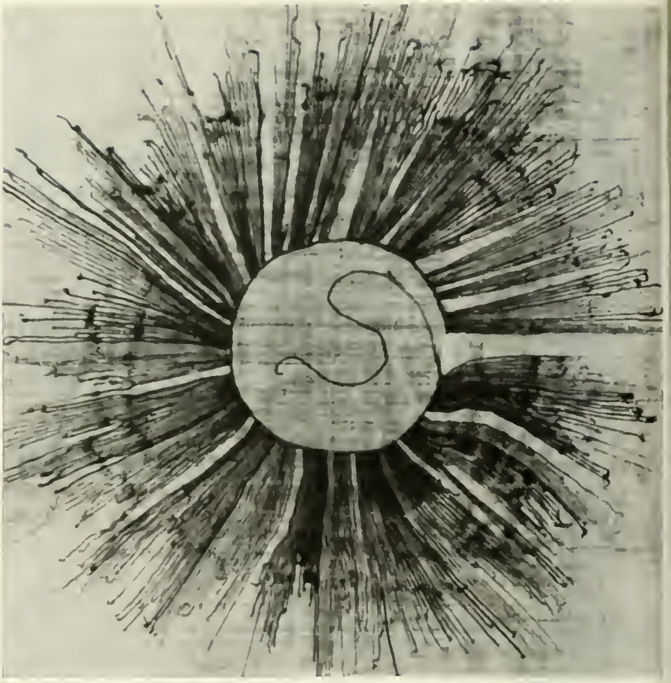


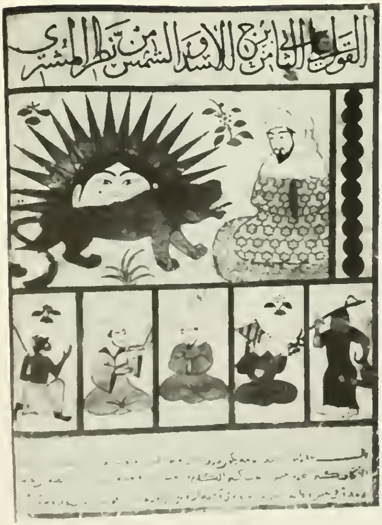
se from Cyclades, at left,
ws sun, sea, and
designs typical of era
m 2500 to 1100 B.C.

Ra, Egyptian sun god, rides in a solar boat, below. Detail is from a papyrus of the 19th dynasty.



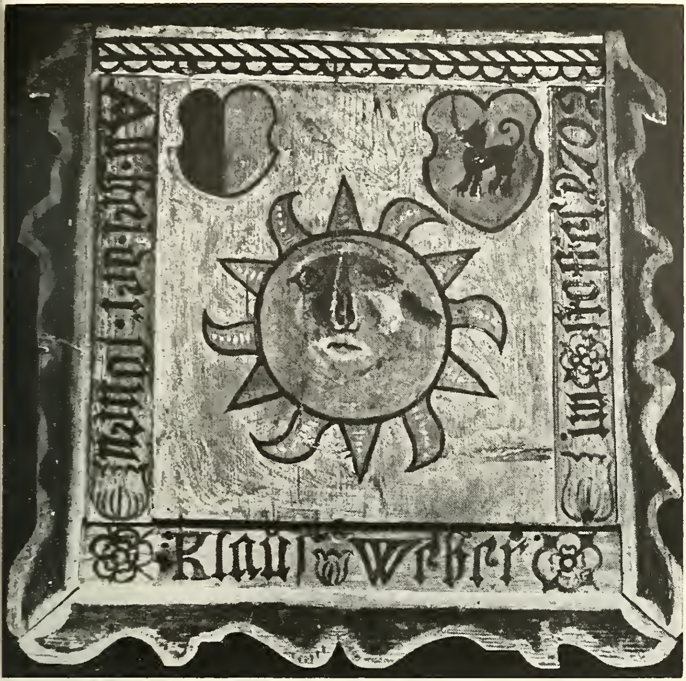
Mnemonic for Peruvian calendar is called a qupu. The solar year is shown by wealth of rays, movement of the sun by the S inscribed at the center.



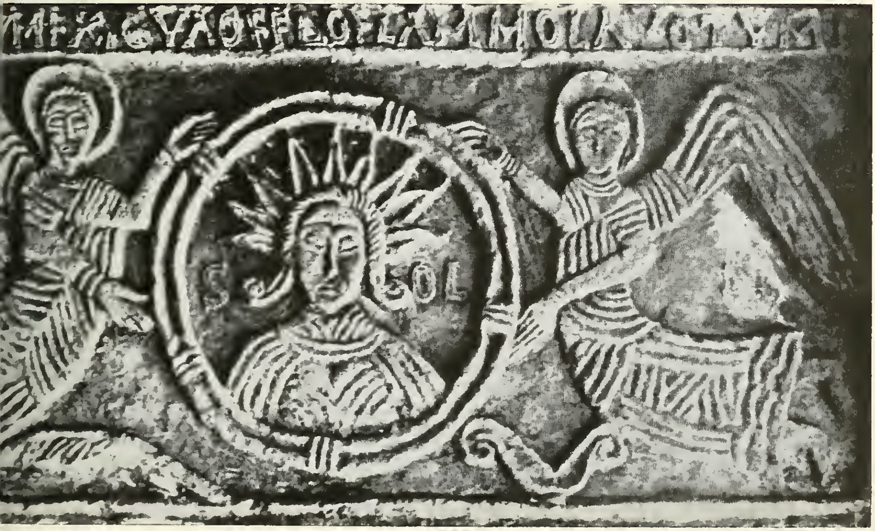


Sun is in the sign of Leo, the Lion (July-August), together with philosopher, left, on page of Arabic manuscript, that might date from the 16th century.

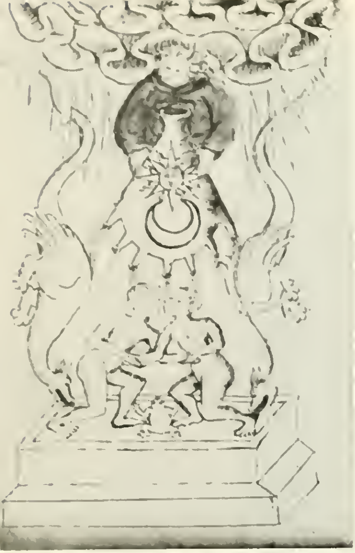
Portrayal of antique sun (Sol) can be seen on a Christian relief made for the 7th-century Church of Santa Maria in the Spanish town of Burgos.


Klaus Weber

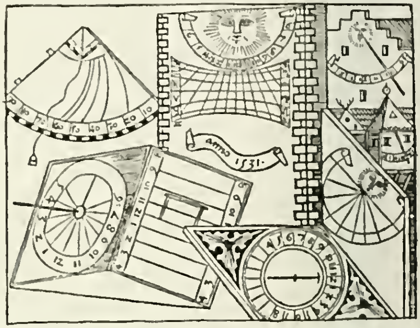
Signs in parts of Europe often portray the sun. This one, painted in casein colors, also carries the arms of Toggenburg. It was made about 1702.



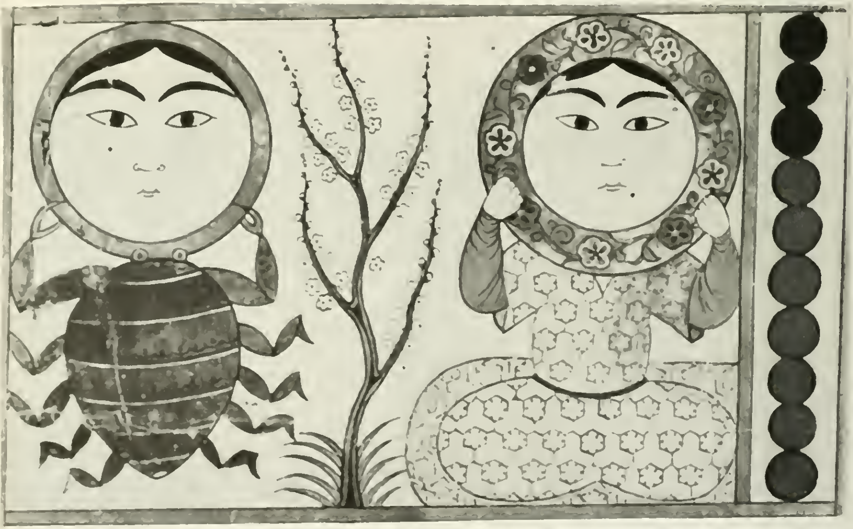
The sun rises; the sun sets. It pursues its path across the small stage of our planet, although in reality we know that it is we who move. The central figure of our solar system, once worshiped as a god, has been relegated to the status of a mere spark, a smallish star among the innumerable stars of the universe. The modern cosmonaut, conquering space in a capsule, desecrates the moon by photographing its far side and may soon indulge in similar photographic familiarities with the once awesome and venerable light-giver, the sun. We have lost the cosmos, says a poet, and have made the sun utilitarian.



Gothic miniature shows alchemy symbols, including those for Sol and Luna, center.

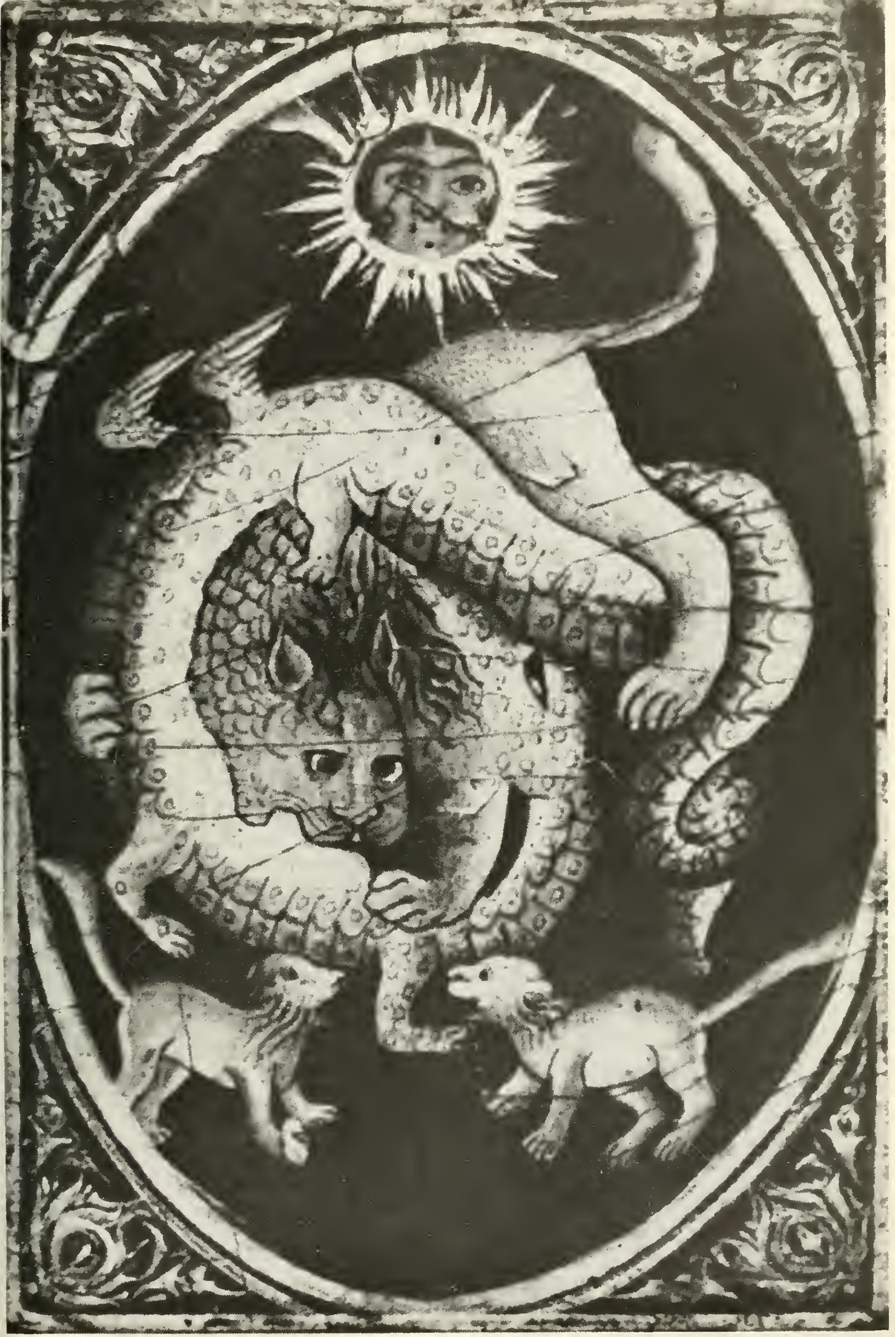


Types of sundials were portrayed in a woodcut from an early astronomical work.



Detail from Arabic astrological treatise shows the sun in the signs of Scorpio and Virgo.

In highest ranking playing card in Persian pack, sun watches conflict of a lion and a dragon.



Familiar Shore Birds

THE SHORE BIRDS OF JAPAN are in many respects comparable with those of one of our northeastern coastal states. In each region one would find two or three species of nesting plovers, one each of woodcock and snipe, a common small river sandpiper, and perhaps one or two other nesting species. Then there would be a host of migrants—some common, some rare or accidental. Many migrants extend down into the Southern Hemisphere – Australia, Patagonia, and South Africa—in winter. For such long-distance travelers, Bering Strait is relatively narrow. It is no surprise, therefore, to find several of the species migrating along the coasts of Japan, of England, or of Long Island! Among these are the sanderling, knot, black-bellied plover, red phalarope, and gray phalarope. In other species, the New and Old World populations differ slightly in size or color and are hence called geographical races or subspecies. These include the turnstones, whimbrels, and tattlers. In a third group, the New and Old World representatives are specifically distinct—for example, the golden plovers,

STREAMLINED, bullet-shaped shore birds are usually remarkable distance fliers.

in Japan

Many are common in New World

By Dean Amadon

he spotted and common sandpipers, nd the semipalmated and ringed lovers. There are also, of course, nany species that are peculiar either to Eurasia or North America. Among he more distinctive and exclusively Old World groups that are represented n Japan as migrants or residents, here are included the lapwing plovers, he painted snipes, and the charming little spoon-billed sandpipers.

The sanderling shown on page 50 is one of the world's most widespread sandpipers. It breeds in the high Arctic—Greenland, Novaya Zemlya, and the like. On migration it does not hesitate to cross wide, watery expanses. I myself have seen one at Haleakala, Hawaii. It is the sandpiper most often seen rushing up and down sandy beaches, following each retreating wave. In the nesting season, its plumage is patterned with bright, rusty brown; winter garb is more somber.

The ruddy turnstone, or "calico snipe," is one of the easiest shore birds to identify. It, too, is a great wanderer. Last June I saw a dozen or so on the tidal flats of a key in the Great Barrier Reef off Queensland, Aus-

tralia. Some were in breeding plumage, and should have been nesting in the far north at that season.

As with other shore birds, nonbreeding individuals often linger in the far south. I recall a missionary from southern Chile who presented a learned paper before the American Ornithologists' Union on the subject. He had seen knots, black-bellied plovers, and other shore birds every month of the year on coastal islands of that country and inferred that they nested there. Plausible but, alas, untrue!

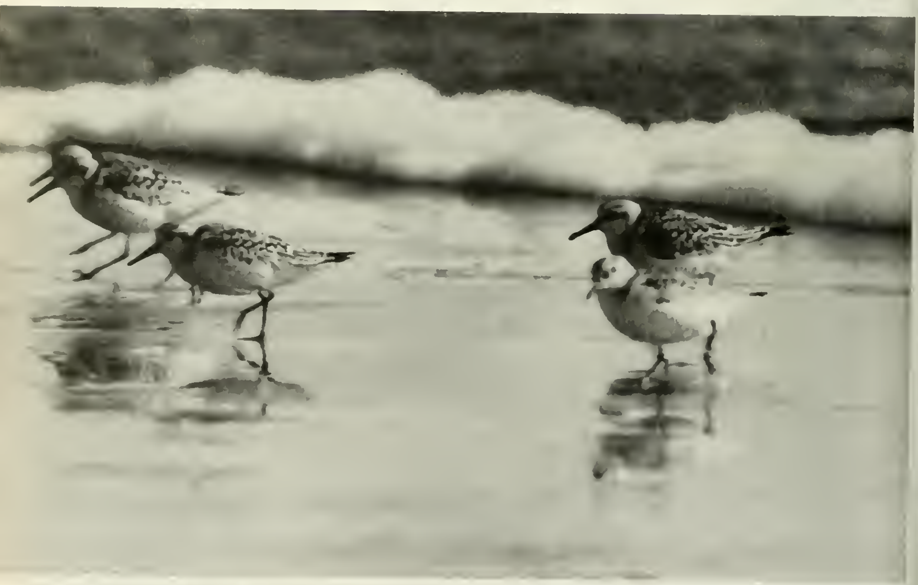
Asiatic knots, if such they are, which appear in silhouette on pp. 18-19, show well the plump, muscular bodies and long, pointed wings that enable them and other sandpipers to range so far over land and sea. King Canute, after whom the common "knot," *Canutus rufus*, was named, ate fifteen of them as appetizers before a state banquet, but said he felt no less hungry than when he began! No wonder that these and such shore birds as the golden plover, Eskimo curlew, and Hudsonian godwit were threatened with extinction, once the modern shotgun had been developed.

My firsthand experiences with Japan's beautiful shore birds are extremely limited. I recall, however, arriving in Kushiro, on the northern island of Hokkaido, tired and stiff after a long train ride. It was June, the days were long, and we walked out a mile or two for a look along a marsh and ridge beyond. In the distance, a marsh harrier flew heavily from one clump of birches to another; nearer at hand someone detected a Von Schrenck's reed warbler. Then a Latham's snipe arose from the marsh, twittered anxiously, circled about, and lit on a telephone pole. Surely it had eggs or young nearby, for only then or when courting will one of its kind seek an elevated perch. This species is, I believe, the only shore bird restricted in its nesting to Japan. (It winters in Australia.) It gave us a fine introduction to the marsh birds of Hokkaido, whose noblest species—the Japanese, or Manchurian, crane—we were to see the following day.

Another very local species is Nordmann's greenshank, which has been found nesting only on Sakhalin, just to the north of Hokkaido. The discovery was made by a Japanese ornithologist, but since World War II this entire island has transferred allegiance to the U.S.S.R. Be that as it may, the Nordmann's greenshank surely must vacate Sakhalin in the winter. Nevertheless, they have been seen only a very few times in Japan just to the south, but are known to winter in the Philippine Islands.

It still is a moot question whether migrating shore birds alight on the ocean to rest. Several species—the golden plover, bristle-thighed curlew and, as mentioned above, sanderling, migrate every year from Alaska to the Hawaiian Islands. This is a hop of over two thousand miles, and makes the gap separating Japan from mainland Asia seem small by comparison.

The latest reference work lists fifty-seven species of shore birds from Japan. Some of these, to be sure, are rare stragglers, but on the other hand species not yet listed may turn up from time to time. Surely, then, bird watchers with whom the shore birds are favorites will find a real challenge in the marshes and the shores of Japan.



One of world's best-known sandpipers is the sanderling, *above*, which migrates from breeding grounds in far north.

Ruddy turnstones, *right*, so called because they flip stones over in hunting for food, have a distinctive chest pattern.

Root Growth Claims Soil from Sea

Mangrove spreads by unique adaptation

By Virgil N. Argo

The red mangrove *(Rhizophora mangle)* has long been a subject of study among biologists. The tree's peculiar habits of root growth, seed production, and dispersal, as seen in the three closely related species that make up the genus, are unique in the plant kingdom. Even a small amount of informal investigation will reveal that here is an individual that has evolved some of the most remarkable patterns of structure and behavior to be found among the land plants.

Rhizophora mangle is found along the coastline of southwestern Florida and the Keys, where there is shallow water not subjected to the full beat of heavy surf and the erosive swirl of rapid tidal currents. It is also widespread along the tropical shallow-water shores of the West Indies, Mexico, Central and South America. A second species, *R. conjugata*, is in tropical Asia, while a third, *R. mucronata*, is along the coasts of Japan, Australia, and East Africa.

There are a number of other trees and shrubs that grow in the same saline, littoral association, which are also called mangroves. Our most widely known examples of these are the button mangrove *(Conocarpus erectus)*, white mangrove *(Laguncularia racemosa)*, and the black mangrove *(Avicennia nitida)*. Of these, the black mangrove, which belongs to an entirely different botanical family, is second only to the red mangrove in reclaiming of land from the sea.

Flowers of the red mangrove are small but are produced abundantly all through the year. The plant begins to bloom when quite young, and isolated plants no more than four feet high have been seen to produce large numbers of flowers, fruits, and seeds. When the precocious development of the seed embryo within the fruit is added to this, one realizes that even though the plant cannot live removed from the vicinity of shallow salt or brackish sea water, its index of dispersal efficiency is high.

Red mangrove off islet's shores will help to extend the margins of the land.

The fruit, which develops after the flower petals fall, is a brown, rough-surfaced, conical structure about an inch long. One seed forms in each fruit, and very early the root tip of the seed's embryo emerges from the summit of the fruit. When it first appears it is narrow in diameter, but it increases in size as it continues to elongate until it may be a foot long and a half-inch thick at the tip. The lower part of this pendent, peglike structure is the root of a new plant. The upper portion, near the fruit, is morphologically the stem. At the stem's upper end, and within the fruit, the cotyledons are attached.

These embryonic seedling leaves, which look much like those in the halves of a bean or peanut seed, apparently do not store food, but instead their function is to transmit it from the parent plant to the embryo. When the projecting root and stem have come close to maximum development, the cotyledons elongate and the stem is pushed forward out of the fruit until an eighth of an inch or more of the cotyledon base is exposed. Between the cotyledons lies the tapering, slender plumule of embryonic leaves. Shortly after this stage, a layer of splitting, or abscission, tissue is formed between the cotyledon bases and the stem. Once this is produced, the pull of gravity or the slightest shake of the branch will be sufficient to dislodge the embryo seedling from the fruit.

Production of flowers throughout the year allows plant to multiply rapidly.

What happens next depends on the environment. If the seedling hangs above mud it may fall and plant itself there, taking root immediately. This procedure is the most widely publicized and certainly does occur under some conditions. But what happens if there is not enough mud to hold the seedling in a vertical position? For the most part, those that drop into the water of the lagoons near Key West strike a hard bottom of limy deposit, so the seedling rises to the surface and floats horizontally. After a period of buoyancy, during which it may be carried far from its point of origin by wind and tidal currents, the root end becomes waterlogged until, in time, the seedling floats in a vertical position with little more than the plumule exposed. It continues to drift in this way until the tip of the root touches bottom in shallow water and the structure goes aground. Then ordinary branching

EMBRYO SEEDLING hangs from conical fruit until abcission allows it to fall.

LONGITUDINAL SECTION shows fruit and seedling before the cotyledons elongate.

AFTER SEPARATION from the fruit, left, seedling, right, is ready to take root.

roots form rapidly, and the young plant is firmly anchored. At the same time, the plumule elongates into a stem with foliage leaves, followed by rapidly produced side branches.

By the time the plant has produced a few small branches, the prop roots start appearing. They sprout adventitiously from the stem above the water line and grow horizontally until they bend down in response to gravity. As they droop, they also send out roots that grow out and up at an angle of forty-five degrees or more. Before this second root tip touches the water it, too, produces one or more upward and outward growing branches that repeat the process. Each of these flying buttresses may have a clear span of two or more feet, and if the water remains shallow, the root system may extend a number of feet beyond the circumference of the leafy branches.

Soon the limbs of the tree start sending vertical adventitious roots down to the water below, and shortly a maze of stems and roots is formed under the branches. These obscure the actual number of separate plants involved, but a small island usually can be recognized as having had its origin in a single plant.

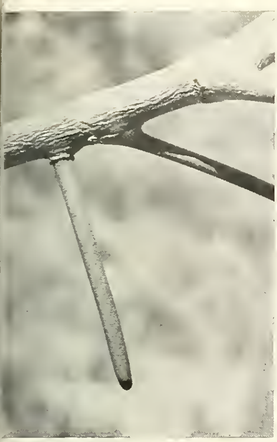
One has to see the tangle of roots and stems of a mangrove island to believe it! Even the prop roots along the edge of a small islet present a most baffling barrier to human locomotion. There are stories, possibly apocryphal, told by people in Key West concerning U-boat saboteurs who attempted to make secret night landings along a mangrove-fringed shore and had to be extricated from their humiliating predicament by daylight.

Mangroves may be seen all along the west coast of Florida, but north of the Ten Thousand Islands they rapidly become smaller and less abundant, presumably owing to the slightly lower temperatures above this point. They are small but common about the islands offshore from Homosassa Springs and Crystal River, but above that latitude they quickly disappear. Along the shore lines of Indian River, on the east coast of Florida, they extend north about the same distance.

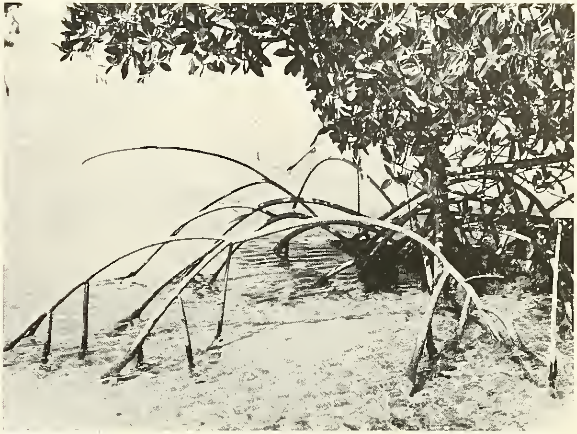
The black mangrove, *Avicennia nitida*, is less spectacular in its growth habits than is the red mangrove, but nonetheless it deserves some special words of recognition. For one thing, its flowers secrete abundant nectar, which is sought after by bees. In common with the nectar of the water tupelo, it furnishes an abundant source of delicious honey that has a high levulose content. The levulose retards crystallization much longer than is the case in other varieties of honey. The two mangroves occupy the same range in Florida, although the black occurs farther north along the east coast.

Its methods of dispersal are not so immediately apparent as are those of *Rhizophora*. The flat, oval fruit, about the size and shape of an unshelled almond, contains one seed. The seed drops into the water while the seedling is still developing and eventually roots in shallow water in the same environment that is favored by the red mangrove. Even while they are small seedlings, little more than a foot high, they send out horizontal roots in all directions on the bottom of the shallows. From the roots there rise vertically, well above the high tide level, a number of slender, pencil-sized pneumatophores reminiscent of cypress knees. These continue to be produced in ever increasing numbers until the space, under and beyond the spread of the tree, bristles with these closely placed respiratory roots. Why the plant should need so many to absorb sufficient oxygen for its below-water tissue is not apparent, but their abundance is of great importance in land reclamation. Added to the maze of *Rhizophora* prop roots, they aid in producing a barrier to the slow, silt-laden tidal currents and permit suspended particles to settle.

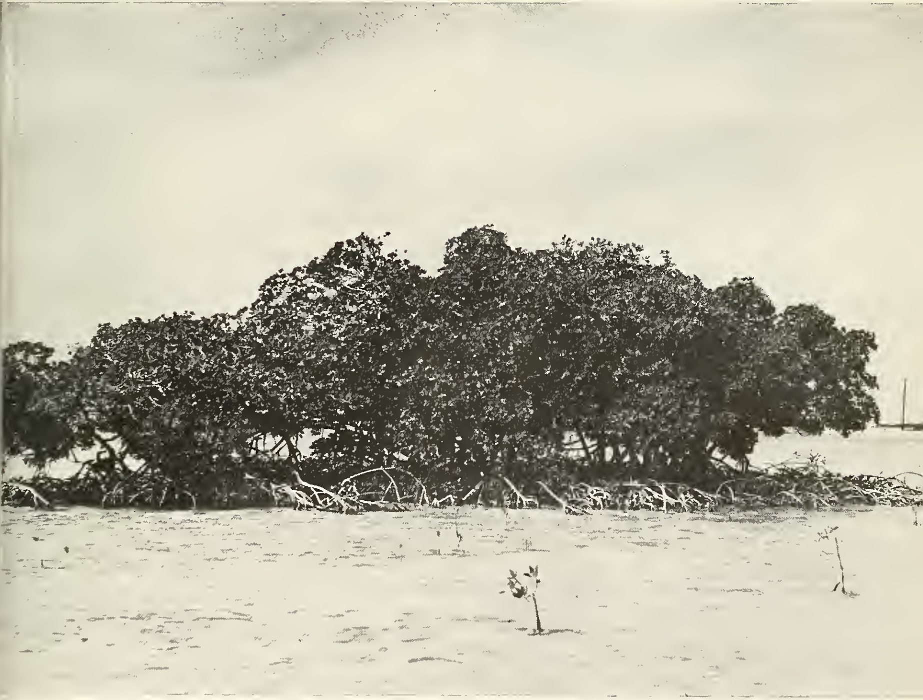
This process soon causes the bottom to rise until the new land, as we can now call it, is up to the high tide level. Falling leaves, droppings of roosting birds, and floating organic debris will in a short time produce a soil on which other halophytic plants can gain a foothold. In no time at all, when compared to the timetable of geologic emergence, new land will appear, continue to build itself above water level, and extend its margins into the shallows. Small islands will grow together, more and more species of woody plants will colonize, and eventually there will be a region fit to be preserved as a wildlife refuge or as a recreation area. And all the while the advancing wave of entangled mangroves protects the island against any counterattacks the sea might make in an effort to reclaim what it has lost.



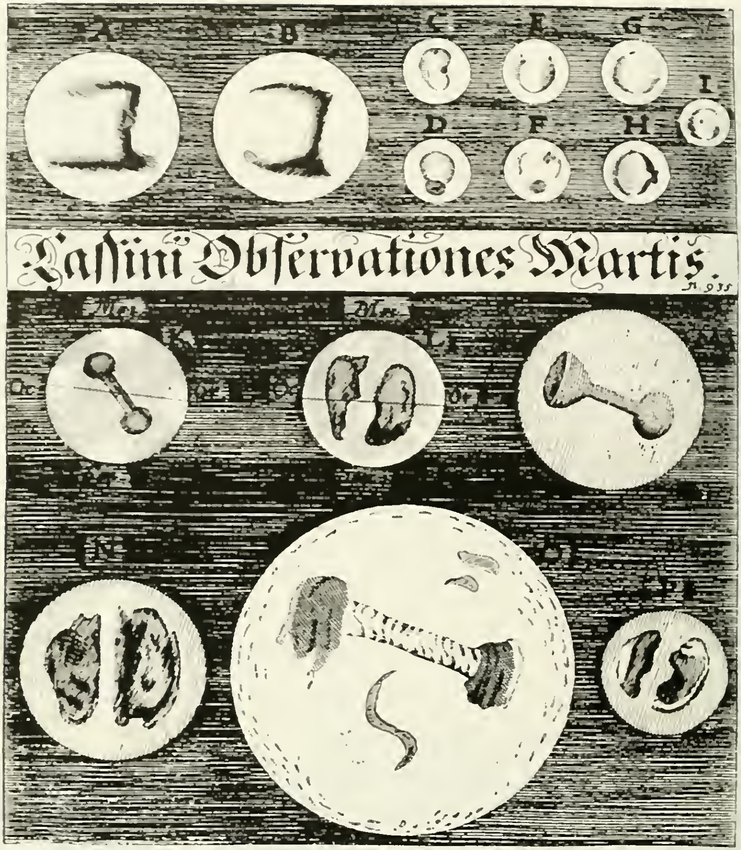
Adventitious roots sprout, like this one, from limbs and grow down to water.



Repeated branching of prop roots up and out from one another may result in dense system that reaches beyond range of foliage, if water is shallow enough.



Young island of multiplying mangroves may have had its origin in a single plant. By blocking tidal currents, which deposit organic debris among roots, plants cause a gradual accumulation of soil, and a new land area is slowly built.



MARS OBSERVATIONS by Hooke and Cassini were published in 1666.

SKY REPORTER

Life may exist on Mars, but mistranslation made the "canals"

By SIMONE DARO GOSSNER

THE PLANET MARS, named for the Roman god of war perhaps because of its ruddy color, scarcely lives up to its mythological reputation. It is so small that early telescopic observers could barely make out its principal features. The oldest known observation, by Francisco Fontana, published anonymously in 1643, depicted it as a triangular rock (NATURAL HISTORY, June-July, 1961). One cannot decide in retrospect whether the poor optics of his telescope distorted the planet's disk into a triangle or whether Fontana mistook Mars' most prominent dark marking—now called Syrtis Major—for the planet itself. Later in the century, Hooke and Cassini, who had better instruments, published the first drawings hinting at the markings (picture, *above*). The "barbell" design that appears in some of them is probably the group of features stretching from Syrtis Major to Mare Erythraeum, another of the prominent dark markings on the surface of the planet.

Mars' two satellites are also very small. They were discovered by the U.S. Naval Observatory in August, 1877. A page of the observing book (see illustration at right)

On these pages **Mrs. Gossner** presents the fourth in her 1963 series—a co-ordinated review of the solar system.

reveals that the larger of the two was first taken for a small, unidentified star near Mars. Its behavior in the next five days revealed its true nature. The second one was found a few days later. They were given the martial names of Phobos and Deimos (Greek for "fear" and "panic").

Both satellites are less than ten miles across. Phobos, 3,700 miles above Mars' surface, travels around it once every seven hours and thirty-nine minutes. Deimos, 8,800 miles farther away, does it in thirty hours and eighteen minutes. Because of their small size, their nature is unknown. In fact, they can be seen only when Mars is relatively close to earth and even then a fairly large telescope must be used. These elusive objects have served at least one scientific purpose: from an accurate determination of their orbits, astronomers have derived a reliable value for the mass of Mars. Satellites provide the only direct means of calculating a planet's mass.

Mars' diameter is 4,200 miles, or slightly more than half that of the earth and about twice that of the moon. Its total mass, however, is only about one-tenth the earth's mass, because Mars' interior probably contains fewer heavy metals. Its day lasts twenty-four hours and thirty-seven minutes and its year has 687 days. Because its polar axis is tilted to its orbit, Mars has seasons as does earth—except they last nearly twice as long, since the planet takes almost two earth years to go once around the sun.

Seasonal variations are among the most thoroughly observed and discussed phenomena of the Martian surface, which has been mapped in great detail. Most conspicuous, even with small telescopes, is the polar ice, which alternately blankets Mars' north and south poles. The icecaps must be very thin, perhaps no more than an inch thick, because they melt rapidly. It was once thought that they might be frozen carbon dioxide (dry ice) but later analysis confirmed that they are ordinary ice crystals.

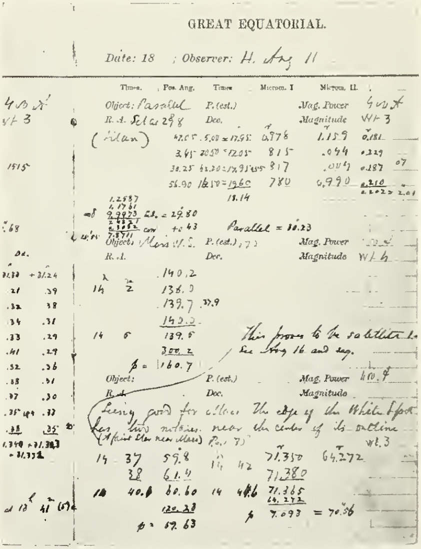
When an icecap melts, the surrounding area takes on a darker shade, probably from moisture soaking into the ground. During Martian summer, some surface markings turn from gray to greenish blue. The same features turn brown in autumn before resuming their winter gray. Many astronomers see this as an indication of some kind of vegetation on Mars. Others have rebutted that chemical changes induced in the soil by alternating moisture and dryness could cause such color variations. Recently, however, spectroscopic observations in the infrared range have shown the presence of hydrocarbon in regions that exhibit seasonal color changes. Since hydrocarbon is a primary constituent of organic matter, it seems increasingly probable that life exists on Mars. But corroborating evidence from other observations limits the possibility to tiny organisms such as algae and lichens.

Astronomers of the late nineteenth century showed much less restraint in their theories of life on Mars. In 1877, the Italian astronomer Schiaparelli discovered that vast areas, believed to be deserts, seemed crisscrossed by a network of dark lines. He called them *canali* (Italian for "channels"). This word proved to be an unfortunate choice. Overenthusiastic translators rendered it in English as *canals,* implying artificial waterways. A lively controversy ensued between those who were convinced that these canals were part of an artificial irrigation system and skeptics who held otherwise. Ironically, the man who had unwittingly started it all took no part in the controversy.

Modern astronomers do not question the evidence of the features that their predecessors interpreted as canals. Rather, they point out that these markings are almost at the limit of visibility even in large instruments. They are so faint that they cannot be properly photographed. Thus one must rely on drawings made at the telescope. In the case of such faint objects, the eye tends to integrate what it sees, and the observer may introduce in his sketch regularities that simply are not there.

Now, artificial irrigation would imply the presence of an organized society on a planet barely capable of sustaining life. Although there is convincing evidence that organic matter is present on Mars, it is very unlikely that any but the lowest forms of life can exist there. Its tenuous atmosphere contains nitrogen, carbon dioxide, a small amount of argon, and, at most, some traces of oxygen and water. Temperatures in the tropics range from about 85°F. at noon to below −95°F. at night. Even though a creature resembling a human being or other warm-blooded animal could adapt to such extremes of heat and cold, the low atmospheric pressure would cause its blood to boil.

Tantalizingly close, yet still beyond our grasp, Mars will be one of the principal targets of space explorations within the next decade. Most interesting is the U.S. project slated for completion in 1967. A piece of string would be ejected from a probe and allowed to drag on Mars' surface. Pulled back into the probe, the string would be nurtured in a laboratory broth, the culture analyzed to ascertain organic content, and the results telemetered back to the earth.



GREAT EQUATORIAL.

Date: 18 ; Observer: H. Aug 11

Time. Pos. Ang. Time Microm. I Microm. II

Object: Parallel P. (est.) Mag. Power 400 X

R. A. Dec. Magnitude Wt 3

Parallel = 30.23

Object: Mars P. (est.) Mag. Power

R. A. Dec. Magnitude Wt 4

p = 160.7

This proves to be satellite See Aug 16 and seq.

Object: P. (est.) Mag. Power 400 X

R. A. Dec. Magnitude

Seeing good for The edge of the White Spot has two notches near the center of its outline

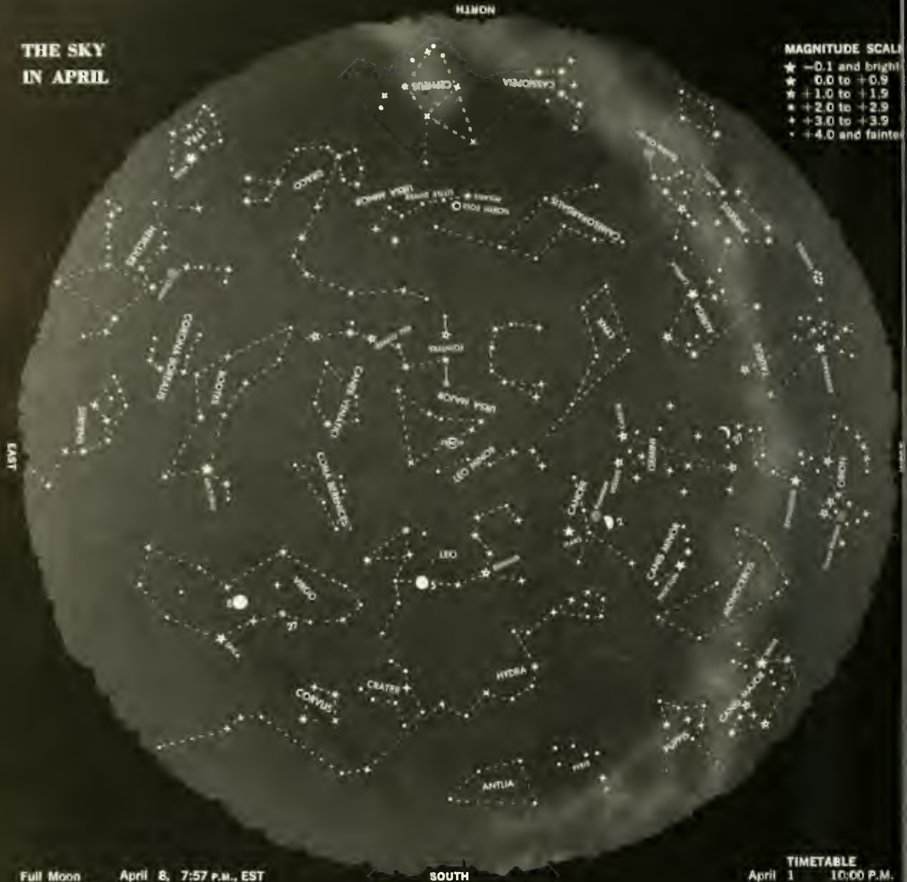
(A faint Star near Mars) wt. 3

p = 69.63

p 7.093 = 70.56

First sighting of a Mars satellite was logged on this page.

THE SKY IN APRIL


NORTH
CEPHEUS
CASSIOPEIA
LYRA
DRACO
URSA MINOR
POLARIS
CAMELOPARDALIS
HERCULES
CORONA BOREALIS
BOOTES
CANES VENATICI
URSA MAJOR
LEO MINOR
COMA BERENICES
SERPENS
PERSEUS
AURIGA
TAURUS
GEMINI
ORION
CANCER
MARS
CANIS MINOR
MONOCEROS
CANIS MAJOR
PUPPIS
LEO
VIRGO
SPICA
HYDRA
CRATER
CORVUS
ANTLIA
PYXIS
8
5
2
27
EAST
SOUTH

MAGNITUDE SCAL

★ −0.1 and bright
★ 0.0 to +0.9
★ +1.0 to +1.9
• +2.0 to +2.9
• +3.0 to +3.9
· +4.0 and faint

Full Moon	April 8, 7:57 P.M., EST
Last Quarter	April 16, 9:53 P.M., EST
New Moon	April 23, 3:29 P.M., EST
First Quarter	April 30, 10:08 A.M., EST

TIMETABLE

April 1	10:00 P.M.
April 15	9:00 P.M.
April 30	8:00 P.M.

(Local Standard Time)

For the visual observer:

Mercury, in the evening sky, will be at its greatest eastern elongation on April 25 and will be favorably placed for observation during the second half of the month. The planet will be too near the sun to be seen during the first half. However, it will set one hour after the sun by April 15, and ninety minutes after on April 30. On April 28, Mercury will be less than one degree from Jupiter. The pair may be distinguished if one remembers that Mercury is the fainter of the two.

Venus, in the morning sky (−3.4 magnitude), will rise ninety minutes before the sun on April 1 and 15 and one hour before on April 30. It will still be low in the east at sunrise.

Mars, in Cancer (+0.4 magnitude), will be nearly overhead at dusk and will set in the northwest at approximately 3:15 A.M., local standard time, on April 1, at 2:30 A.M. on April 15, and at 1:45 A.M. on April 30.

Jupiter, in Pisces (−1.6 magnitude), will be drowned in the sun's brilliance during the early part of April. It will rise forty-five minutes before the sun on April 15 and ninety minutes before on April 30, but will be seen only by observers who can secure a clear view of the eastern horizon.

Saturn, in Capricornus (+1.0 magnitude), will rise two hours before the sun on April 1, two and one-half hours before on April 15, three hours before on April 30, and will be found in the southeastern sky at dawn.

The Lyrid meteor shower is expected to occur on April 22. In past years, its maximum rate has been of the order of ten meteors per hour (as seen by a single observer). Observing conditions will be favorable because there will be no moonlight on that date. Although all meteors of a given shower enter the earth's atmosphere in essentially parallel paths, an effect of perspective makes them seem to radiate from a point on the celestial sphere, called the "radiant" of the shower. A familiar example of this illusion occurs on highways: the parallel roadsides seem to diverge from a point on the horizon. Most showers are named for the constellation in which their radiant lies. Lyrids, for example, radiate from a point in Lyra. The maximum rate is attained when the radiant is overhead. Far fewer meteors must be expected when the radiant is low in the sky. Visual observations may be recorded on a sky map by locating the point where each meteor was first seen, then drawing the direction and length of its trail.

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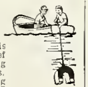

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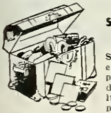

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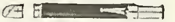

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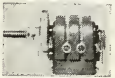

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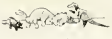

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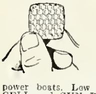

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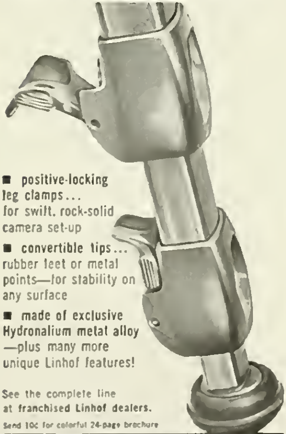

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FAR AND NEAR

Border cultures affected Thai society

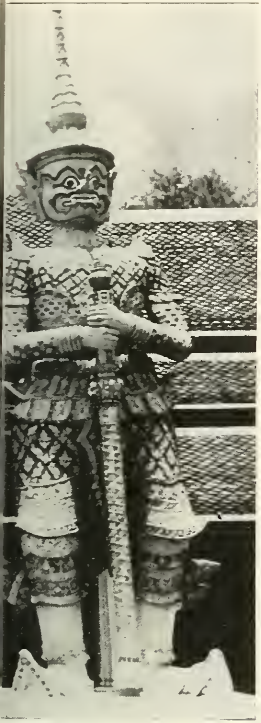
By Tim Spierings

Once partially afloat on pontoons, its largest edifices built on piles beside interlacing canals, tropical Bangkok in Thailand, though it has changed with time, still remains the capital city of the only Buddhist kingdom in Asia, or, indeed, in the world.

More than three hundred Buddhist temples, exotic with their brilliantly colored tile roofs and gilded spires, are scattered throughout the city, making modern Bangkok seem, to the fresh eye, an ancient, ancient city. In fact, it is younger than New York or Philadelphia.

Bangkok was built by King Rama I of the Chakkri dynasty. In the late eighteenth century Thailand suffered one of its frequent invasions by the Burmese, who, after a long siege, plundered and then razed the Thai's wealthy commercial capital and holy temple city, Ayuthia, the ruins of which are still visible. Most famous of all the many large and tiny temples that the Thais were to build in the new capital city of Bangkok after this war is Wat Phra Kaeo, fabled temple of the emerald Buddha. The temple is set in the royal palace erected by Bama I, which is a spectacle of ascending gilded spires and towers that are protected by surrounding white walls.

I found that the palace, today, houses two strikingly unrelated worlds: one spiritual, the other mundane. The older section of the palace with its pagoda temples, is a repository for the art of religion, legend, and culture, while the newer buildings are the seat of the modern royal government.



LD-HELMETED *Yaks* repel mythical spirits.

The old palace, of course, was the ief concern of this tourist, who found to be opened to visitors during certain ekday hours – but for a fuller and easanter excursion, I decided to go to the palace on a feast day, for then populace of Bangkok would enter. From afar, I viewed the numerous ining towers and stupas above the wall. ntering through the main gates—a privi- ge accorded only to feast day crowds moved among the lighthearted Thais. me carried flowers, others had bought e birds at the gates. Soon they set the ds free inside the palace grounds, a sture that helped the grantor of their erty to move a step nearer his personal vana, the final spiritual emancipation the Buddhist as well as for the Hindu.

SIDE the white walls, I was baffled by the complex of temples, stupas, mes, pagodas, the glitter of gilded lls, marvelous tile mosaics, and intri- ely detailed murals. It was such an erwhelming first impression that I rdly knew where to begin looking.

But perhaps the quiet of the palace buildings was the most strange and impressive aspect of the area. In spite of the feast day crowd, there was an aura of solitude in which I could confront the stormy colors and seek out the smallest details of the epic tales portrayed in paintings and statuary.

As if enforcing this respectful silence, enormous statues of *Yak* guardsmen stood everywhere beside doors and in halls, glaring fiercely down at the feast day crowds. They looked like demons with their fixed, grim expressions and snarling mouths. In Thai mythology, the *Yaks* guard holy sites against evil spirits, mischief-bent intruders, and thieves, and they are most efficient sentries, I am sure. Satisfied that this visitor had no evil intent, the *Yaks* allowed me free passage to the mausoleum of the old kings.

The mausoleum was flanked by ornate, gilded pagodas. Tiers of demons from the *Ramayana*, the Hindu epic of Rama, decorated the gilded pagodas. The more elaborate the pagoda, the fiercer seemed the ornamental demons. Their backs were braced as though to support the full weight of the stupa, and their modeled faces appeared to be irritable because of the burden. Gilded female sculptures adorned entrances and walls. Most were ladies-in-waiting of the former royal court in attitudes of obeisance. Although some had tails and animal hoofs, they were extremely feminine and dignified.

I moved on to the library where myriad sacred books and scriptures of Buddhism were preserved. The library's façade was richly invested with sculpture and inlaid with mosaic tile tableaux. Small bells dangled from the eaves and tinkled in the wind, soothing the evil spirits.

Guarding the library were two ferocious, helmeted *Yaks*, with an entourage of dragons lining the railings. In Thailand I saw Chinese, Ceylonese, and Burmese influences. The Thais, historically at a crossroads and an active trading country, borrowed traits from invading neighbors and from all with whom they carried on commerce. They enliven their passive Buddhist religion with festivals, dances, and games. Unlike many Asian cultures, they actively desire a prosperous way of life, and readily employ the animals, agronomy, and commerce needed to attain prosperity. Their art and iconography sometimes seems eclectic, with liberal borrowing of the forms and symbols they appreciated in neighboring cultures.

The smaller temples in the palace area were adorned with flowers of all colors. The area encompassed by this palace, located at the center of the city, is a very challenging square mile to cover. I learned that the main stupa was used to keep relics of Gautama Buddha, but, of course, these were not all authentic. In Asia, there seemed to be as many or

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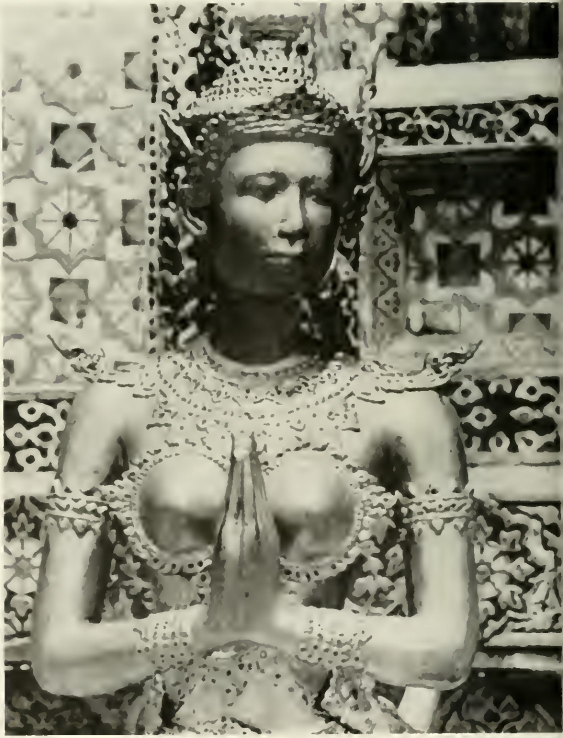
more alleged relics as there are pieces of the true cross for sale to tourists in Jerusalem. Naturally, every effort was made to house only true relics of Gautama Buddha in the main stupa.

I was deeply impressed by the throne room, umbrella throne, and sculpted elephants. (In Thailand, elephants were once sacred, and today appear on the country's official seal. It was illegal to hunt or kill them, although they were used for labor in the forests.) Behind the throne was a model of Angkor Wat, a temple city in Cambodia where the Khmers once lived, and where their descendents live today. The Thai razed this city when they migrated south 5,000 years ago to occupy Thailand.

Much of the old history of southeast Asia seems to suggest the history of the classical little world of the Mediterranean, with constant wars between neighbors and the pervasion of one super-



GILDED court ladies have winged shoulders and calves, stylized animal legs and tails.

ɪʙʟᴀᴢᴏɴᴇᴅ spires like these in Bangkok
ice dotted skyline of now-ruined Ayuthia.

·ially similar culture, with elements
ntributed by all. I was struck by a
agnificent mural painting on the walls
the palace gallery, and discovered that
was a depiction of the *Ramayana*, the
mous Hindu "Odyssey." Rama, with
s wife Sita, wandered through this
orld much as Odysseus moved through
s Mediterranean counterpart, and
ese murals are said to be the only place
Asia, or the world, where the whole
ngth of the *Ramayana* is portrayed. If
is is true, it should be fully photo-
·aphed now for posterity, because much
badly damaged and in alarming
ages of decomposition.

)ᴜᴛsɪᴅᴇ, under the gallery roof, I
stared again at the busy, conflicting
rms and colors everywhere, still with
y initial sense of naïveté and wonder
this elaborately sophisticated world.
hen I walked to the famous main temple
the Wat Phra Kaeo, temple of the
ibled emerald Buddha.

Palm trees screening the façade and a
gure reposing beneath a lotus flower en-
anced the classic serenity that marked
ie temple. The lovely Oriental lady be-
eath the lotus blossom was allegedly
wan Yin, or the Japanese Kwannon, the
oddess of mercy.

Said to be Ceylonese in origin, the
uddha was an astounding thirty-one
iches tall, carved from a single emer-
ld, and dressed in garments that
hanged with the seasons. Unfortunately,
was not permitted to take pictures.

I left this last and especially holy
emple by the same side door I had come
ı. The main doors are only for royalty.

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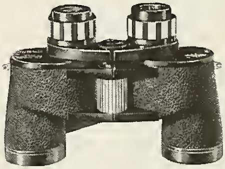

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About the Authors

DR. JANE C. GOODALE, author of the article about the Tiwi's strange yam ceremony, is a Lecturer in Anthropology at Bryn Mawr College. She first observed the Tiwi on Melville Island in 1954, when she was a member of a National Geographic Society Expedition. Dr. Goodale revisited the island during the summer of 1962 to gather additional material. She took the photographs that accompany the article, including the dramatic study on the cover of this issue.

Under the title "Beauty and Science," DR. MEREDITH L. JONES presents a scientist's appreciation of aesthetic pleasures that greet the naturalist. Dr. Jones is Assistant Curator of THE AMERICAN MUSEUM's Department of Living Invertebrates. The photographs of marine creatures were made by Mr. Douglas Faulkner, a photographer who is keenly aware of the beauty in nature.

DR. LAWRENCE W. SWAN, Associate Professor of Biology at San Francisco State College, discusses ecology at high altitudes in the article beginning on page 22. Dr. Swan's profound knowledge of his lofty subject stems, in part, from participation in the American Himalayan Expedition of 1954 and in the Himalayan Scientific and Mountaineering Expedition in 1960. Of the latter he says, "I walked across those mountains, up and down and on and on, for a full thousand miles." Mr. Frank Haines based drawings on Dr. Swan's material.

The praying mantis is the subject of "Beneficent Cannibalism," by MR. EDWIN WAY TEALE, noted naturalist and author. The article was excerpted from Mr. Teale's recent book, *The Strange Lives of Familiar Insects*, published by Dodd, Mead & Company. Mr. Teale, an adept nature photographer, took the pictures that appear with his article.

A survey of Japanese shore birds by DR. DEAN AMADON discloses the unexpected fact that several species are also encountered thousands of miles from Japan, in the New World. Dr. Amadon is Lamont Curator of Birds at THE AMERICAN MUSEUM and Chairman of the Museum's Department of Ornithology. His scientific specialties include avian taxonomy and bird evolution.

The growth of mangroves is described by DR. VIRGIL N. ARGO, who recently retired as Associate Professor of Biology at The City College of New York. For twenty years Dr. Argo has done illustrative photography in the biological field, concentrating on botanical subjects. He has made five trips to Mexico and five trips to Europe and North Africa, spending two sabbatical leaves in the Mediterranean region, where the botany and agriculture hold particularly strong interest for him.

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NATURE and the CAMERA

How to select the "right" camera

y DAVID LINTON

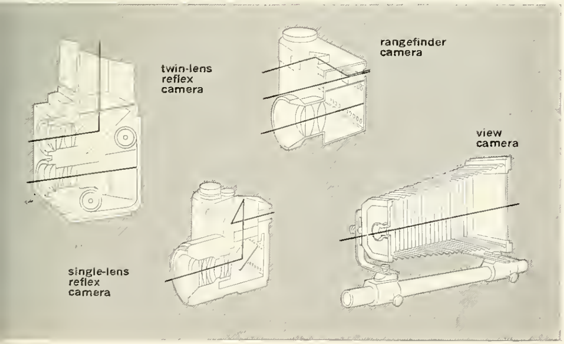
NATURE PHOTOGRAPHS can be made with almost any kind of equipment, ut some types are more convenient han others. The choice should depend n the field of nature photography that ost interests the photographer. And it hould be remembered that an expen-ve camera is not a better choice than n inexpensive one unless the features hat make it expensive are used.

The late Alfred Stieglitz, eminent merican photographer and proponent f photography as a fine art, is said to ave remarked that no one had ex-austed the creative possibilities of the ox camera. Whether or not he said it, is a sound observation. Generally, an nexpensive camera that you know how use is better than an expensive one of hich you are unsure. There is a wide-pread belief among neophytes that ex-ensive cameras are complicated while nexpensive ones are simple. This idea robably stems from comparisons of box ameras with cameras on which the shut-r speed and aperture can be changed, nd lives on because it is comforting believe that something one cannot af-rd has great disadvantages. Actually, ood equipment, whether expensive or ot, is simple to use, although the me-hanism inside may be complex.

Rapidity of operation is one of the ew ways in which the type of camera sed has any relevance to the results chieved. Consider this example. In the ingle-lens reflex class of cameras, de-ned below, the better models have auto-atic diaphragms and mirrors. With such cameras the change from viewing condition to picture-taking condition and back again is accomplished by one squeeze of the release button. With many less expensive single-lens reflexes the diaphragm must be closed by turning a ring on the lens mount before the picture is taken. It must be reopened after the exposure by turning the ring back again, and the mirror must be returned to viewing position by winding the film advance. The sequence of operation is time-consuming.

The automatic features of the more expensive single-lens reflex make it capable of photographing events that happen too quickly to be caught by the manually operated camera. A rangefinder camera would, in turn, be faster to focus than one with a ground glass.

The inexperienced photographers, to judge by those I have met, are more likely to have too many features on their cameras than too few. The most common waste of money is on fast lenses. Manufacturers have found that the public thinks fast lenses are better than slow ones, and they have done nothing to correct this misapprehension. In reality, a high-speed lens, like any other feature, is valuable only if you need it. It is a liability if you don't, because something has to be compromised in the lens design to achieve the high speed. Usually it is the sharpness at small apertures that suffers. One of the first high-speed lenses for 35 mm. cameras was made so that it could not be stopped down beyond f/11 because in preproduction tests the im-



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age fell apart at smaller apertures. Advances in lens design and manufacture since World War II have brought improvements in speed, sharpness, and various optical corrections so that some fast lenses are now better than some slow ones, simply because they benefit from modern techniques.

If you have been taking pictures for some time, there is a simple test to see if you need a faster lens. Estimate the percentage of pictures you have taken at the maximum aperture of your present lens. Then estimate the percentage of pictures for which you would have used a larger aperture had one been available. If either figure is large enough to notice, your experience is exceptional and the purchase of a faster lens is justified.

How should one go about choosing a camera? By deciding first where his photographic interests lie and then selecting the camera that will do such work best from among the cameras he can afford. Most cameras can do most types of work acceptably, but one that is properly chosen for the job may be so much more convenient that it increases the range of possible pictures.

CAMERAS can be classified by the shape of film they use or by their system of focusing. Film comes in sheets, in short rolls with a paper backing, or "roll film," and in longer rolls without backing paper, for which there is no convenient generic name. The last type is usually encountered in the form of 35 mm. film, although some specialized cameras use the same sort of film in 70 mm. or other widths.

Various types of film differ in more than shape. The emulsions of different-sized films of the same brand are often dissimilar—even when they have the same name—and so is the base, or supporting material. There exists a hybrid stock called film pack, which is roll film cut into sheets and attached to short strips of backing paper. It is inconvenient to shoot, process, and print from.

In my opinion, the advantages once claimed for large film sizes have been eliminated by modern emulsions, which make it quite possible to obtain any desired negative characteristic on any size of film. Film size, therefore, is not a consideration in itself. Other factors, such as the availability of certain emulsions or the ease with which certain manipulations can be performed may, however, point to one or another size for certain uses. For example, High Speed Infra-Red film is not available in sheet sizes, or orthochromatic material in rolls. Only continuous films, such as 35 mm. or 70 mm. stock, are practical when a large number of pictures are to be taken by a remotely controlled or automatic, unattended camera. Polaroid "instant image" film is very useful in making test

LABORATORY SCENE was photographed wit
twin-lens reflex camera, a design that

exposures for immediate examinatio
before the final picture is made. This fil
can be substituted for the regular fil
only in sheet film cameras for whic
adapter backs are available. For som
kinds of work, obviously involving sul
jects that do not move, the availabilit
of this material is a compelling conside
ation in favor of the large camera.

Characteristics of the camera itse
may make it more appropriate for ce
tain types of work. Only the view can
era has adjustments, called "swings an
tilts," for rendering parallel lin
parallel and controlling perspective s
that accurate size determinations may b
made from the photographs. It is con
sequently the first choice for architectur
photography and some technical use
Among the view camera's other uniqu
attributes is the ability to change it
apparent viewpoint without actuall
being moved; that is, within limits it ca
take a picture that appears to have bee
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common problem of photographing
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DAVID LINTON's by-line has appeared under photographs in all the nation's leading magazines. His camera column is a regular feature on these pages.

ɪnvenient for covering subject of medium ze at moderate distance from the camera.

·der to get the top of the subject in the cture. a photographer using any maıine otber than a view camera must p the camera upward. But when he ɔes so the subject appears to lean ıckward. The correct solution is posble only with a camera on which the ont and back can be "swung" (rotated ı horizontal or vertical axes) or "slid" moved laterally or up and down). hese movements. once the photographer arns to use them. give the view camera reat accuracy as a recording instruıent and great flexibility as a tool of eative potential.

Of course, for these controls to be sed, the camera must be mounted on fixed support, usually a tripod, and it ıust have a ground glass on which the hotographer can see the entire image. ;onsequently, this type of camera is ɜally practical only for large film sizes -4 x 5 and up — in which the available lms are in sheet form. These factors ombine to make the view camera large, eavy, and slow to operate. The view amera also requires many accessories tripods. film holders, and so on), but : provides unmatched image control.

Cameras that use sheet film but do ɩot have swings and tilts no longer ɪrovide any advantages and are fast ɪecoming obsolete. The "press camera" ɪelongs to a bygone era. It was designed ɔ meet two needs: to provide fast hutter speeds at a time when the 'window blind" type of focal-plane hutter was the only way of achieving hem, and to use the first flashbulb, vhich was the size of a 100-watt bulb. Today even press photographers have largely abandoned the press camera for lighter and more adaptable equipment.

The one advantage of the press camera is its sturdiness. There isn't much mechanism to go out of order. The "miniature press camera." smaller than 4 x 5, is as useful as a miniature printing press.

There are some cameras in a limbo between the press and view categories. It is usually claimed that they are both, but they have the advantages of neither. A camera cannot function like a view camera if it is enclosed in a press camera's rigid box—the box obstructs the swings. The only notable advantage of such cameras is that, like press cameras, they are sturdy.

The cameras we have discussed are designed to use sheet film, although adapters permit the use of roll film in some of them. Some also have rangefinders, but the primary method of focusing is by a ground-glass screen mounted in the film plane and examined directly, sometimes with the aid of a small magnifier. After the image is in focus the ground glass is moved out of the way and is replaced by the film, encased in a holder. This system of focusing is generally impractical in small sizes because the photographer cannot see a small image clearly enough to focus precisely. It is used, however. with a magnifier in some copying devices that use small film.

Smaller cameras use reflex or rangefinder focusing. There are, of course, cameras with no built-in focusing system at all. Good pictures can be made with them, but their usefulness is limited.

REFLEX focusing uses a ground glass that, instead of being in the same place later occupied by the film, is at exactly the same distance from the lens as the film, but in a different position. In the single-lens reflex camera, a movable mirror diverts the image from the film plane to the ground glass. The twin-lens reflex uses one lens to take the picture and another to project an image on the ground glass.

The rangefinder camera has a separate optical device to measure the distance from camera to subject and uses this information to focus the camera through a mechanical coupling to the lens. The rangefinder works by juxtaposing images seen through two windows a few inches apart. The apparatus is adjusted until the two images coincide; then the angle between the two lines of sight indicates the distance to the subject. This is basically the same mechanism that gives depth perception to humans and other animals with binocular vision, but more factors are involved in depth perception.

Some reflex cameras have a prismatic "rangefinder spot" in the ground glass, on which the image appears split or

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Animals in the wild, like this deer, are natural subjects for a rangefinder camera, which may be focused and operated fast, and is usually lighter than other cameras.

disrupted when it is out of focus, becoming whole and well defined when the focus is sharp. This is not really a rangefinder, but rather a magnified device to show easily when the ground-glass image is in focus. It is sometimes useful, but usually less so than the purchasers of the cameras expect. The spot often "blacks out" at low light levels, when used with slow or very long lenses, or when making extreme close-ups. The latter two situations are precisely those for which the single-lens reflex camera is best adapted, so the rangefinder spot should not be taken too seriously as a selling point. It is certainly desirable for a camera that has one to have provision for substituting a plain ground glass for the one with the spot. There is, incidentally, one camera on the market that has a genuine rangefinder in addition to, but completely separate from, its regular reflex viewing system. It succeeds in preserving most virtues of both systems.

ADVANTAGES and disadvantages of the three types of small cameras may be summarized as follows:

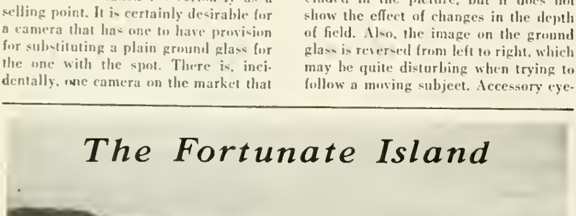
The twin-lens reflex is the best choice for the beginner. It is the camera to buy if you photograph a variety of subjects and can have only one camera and no extra lenses. The viewing system makes it very easy to see what is included in the picture, but it does not show the effect of changes in the depth of field. Also, the image on the ground glass is reversed from left to right, which may be quite disturbing when trying to follow a moving subject. Accessory eye-level viewers may be attached to some twin-lens reflexes and will provide an unreversed image. The twin-lens reflex is convenient at moderate distances and for medium-sized subjects, such as people. It is not a good choice for extreme close-ups because of the difference in viewpoint between the viewing and taking lenses. Because there are two lenses coupled together, it is not really practical to change lenses on this type of camera. In fact, it is impossible to do so with all twin-lens reflexes but one.

Single-lens reflexes are best for use with long lenses (as when photographing wild animals) or for extreme close-ups (photographing flowers, for example), but they are not so convenient to use at moderate distances. Single-lens reflexes will accept a wide range of lenses, but extreme wide-angle lenses may be difficult to use because some extend so far into the camera that they block mirror movement, preventing use of the reflex focusing system. It may also be difficult to judge focus with lenses that are short, slow, or both. A reflex with fully automatic diaphragm and mirror is much more convenient to use than one without these features.

THE rangefinder camera is usually lighter in weight, can be operated faster than any other type, and is the easiest to focus in dim light. Since the rangefinder is optically independent of the lens, it is equally accurate and equally bright for all lenses, fast or slow, long or short. Focusing is easy but seeing exactly what is included in the frame may be a bit difficult with other than normal lenses. Sometimes an accessory view finder is required, which means that the eye must be shifted from one window to another. The rangefinder cannot be used with very long lenses or for extreme close-ups, but the camera may be used with an accessory reflex viewing device, which, in effect, converts it into a single-lens reflex.

With these points firmly in mind, the photographer should be able to analyze his interests and make an enlightened choice based on his actual needs, thus preparing himself for the "moment of truth" when he faces a camera salesman.

The Fortunate Island



Ten miles off the coast of Maine, compass'd by the primitive wilderness of the sea, lies Monhegan, an Island in Time.

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THE ISLAND INN, BOX HA, MONHEGAN ISLAND, MAINE

This list details the photographer, artist, or other source of illustrations, by page.

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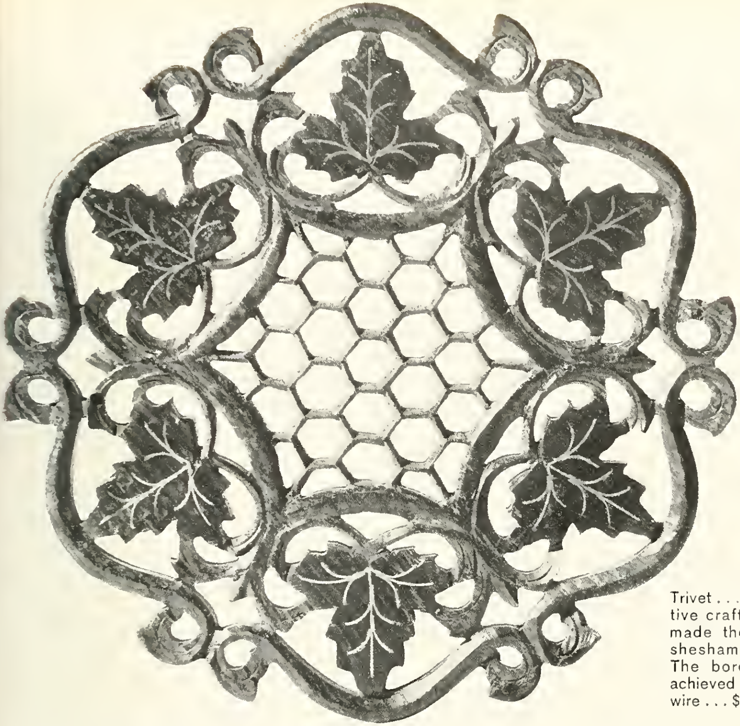

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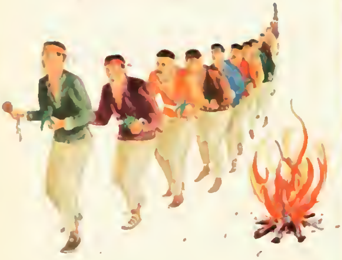
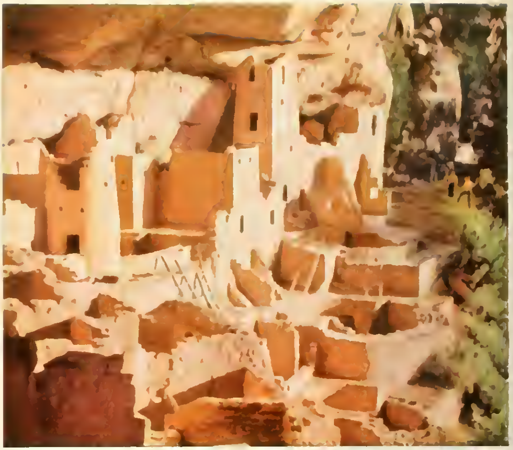


Watch but do not photograph local Navajo dances. Indian religion forbids pictures.



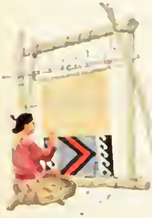
The Cliff Palace is one of Mesa Verde's most picturesque ruins.

MESA VERDE

where you discover the people time forgot

If you've ever dreamed of being a great explorer and discovering a "lost civilization," drive to Mesa Verde National Park in Colorado and start looking. America's first great civilization vanished here 200 years before Columbus; you might help archeologists piece its history together.

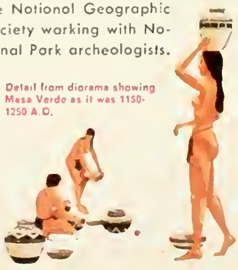
Actually, there were three cultures: the prehistoric Hunter-folk, the Basket Makers of 700 A.D., and the "Ancient Ones" whose cliff-dwellings still perch like fantastic swallows' nests on the canyon walls. Each is pictured in the museum dioramas which trace their development from savage nomads to a high culture that built 200-room apartment houses, grew corn in irrigated fields and traded for salt and jewels. Their pottery, jewelry and textiles, displayed here, are fabulous.



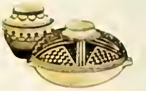
Age-old patterns are still woven by today's Indians on looms little changed through the centuries.

But no museum is as exciting as an actual visit to their homes, dug into the earth of the Mesa, or, like the Cliff Palace, built on the cliff faces. As you go past room after room, you half expect to meet one of the women who ground corn here, or the child whose handprint you see on the wall. In the kivos or ceremonial rooms, which were built underground to be near the Corn Goddess, you can almost hear the prayers for rain.

No rains came; by thick or thin rings on the "tree calendar," scientists know that a long drought began in 1276, and in a generation, this civilization withered and died. But its grandeur remains and even today, more of its history is being revealed by the National Geographic Society working with National Park archeologists.



Detail from diorama showing Mesa Verde as it was 1150-1250 A.D.



You can still see the artists' fingerprints on many ancient vases.

Within a day's drive of Mesa Verde are other historic and scenic wonders — Aztec Ruins and Chaco Canyon in New Mexico, Arches and Natural Bridges in Utah, the Petrified Forest and Canyon de Chelly in Arizona. Come and enjoy these treasures of our natural heritage set aside by patriotic conservationists for the enjoyment of all Americans.

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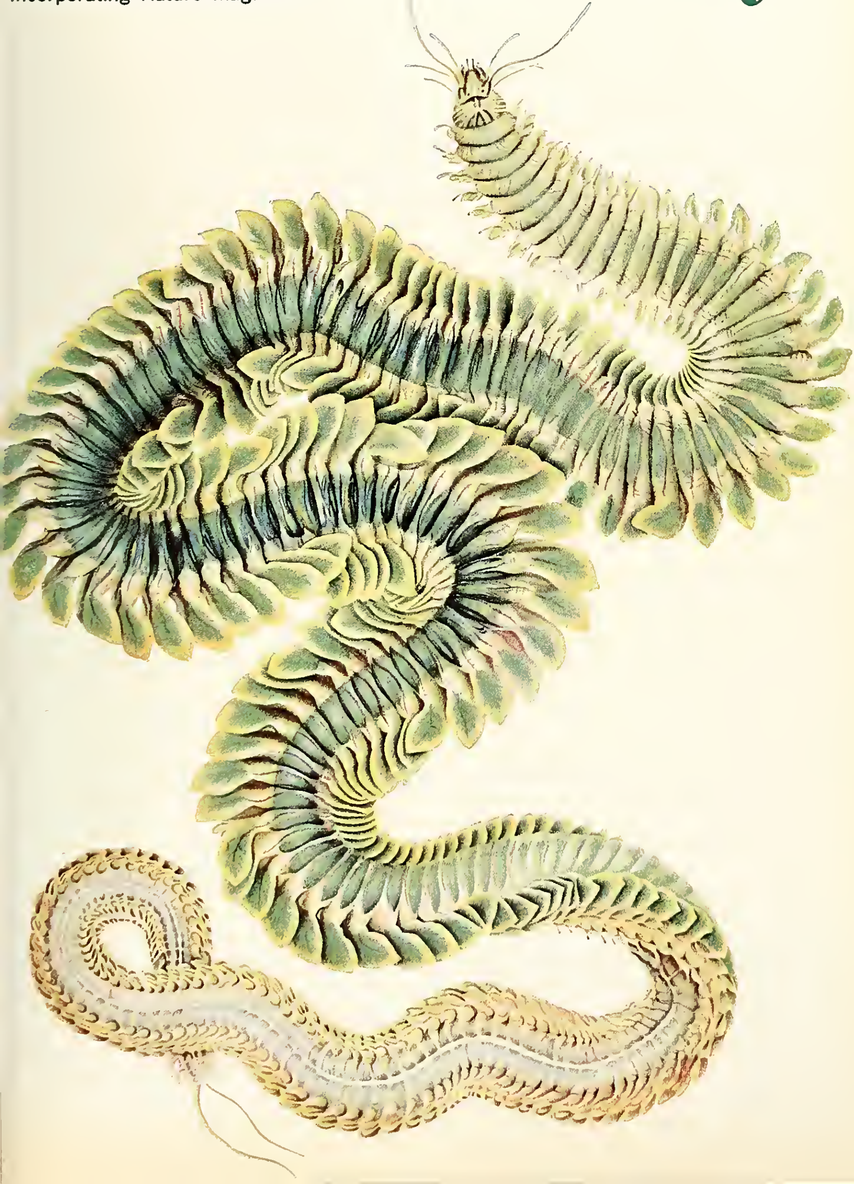

Why is Great Smoky our most popular National Park?

View from Clingman's Dome in Great Smoky National Park between Tennessee and North Carolina

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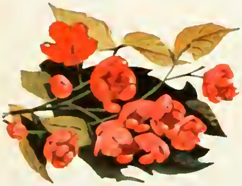

The beauty of this plant matches its name—'Heart's-a-bustin'-with-love'"

You can often see bear and deer. In the hills, you may hear wild turkey gobbles. More than two hundred birds have been identified.

At Cades Cove, there's a pioneer village to visit. Indians, too. At nearby Cherokee Village, you can watch blanket weavers, or tribal ceremonials unchanged in centuries.

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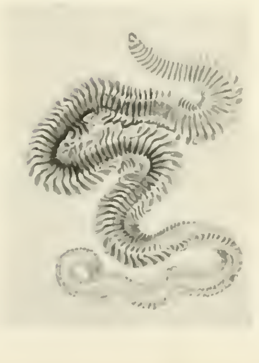

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THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

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COVER: This extraordinarily convoluted animal is *Nereis virens*, a marine worm familiar to fishermen, who use it for bait. It is most commonly found among mussels on pilings, under rocks, or in muddy sand, and is known by a variety of common names. This species of nereid is found in Norway and on the east coast of North America. It ranges in length from one to three feet, its body has 173 or more segments, and its diameter at the widest point is up to one and three-quarter inches. This and other illustrations accompanying the article that begins on page 10 are from *British Annelids*, by W. C. McIntosh.

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INTERPRETER

Slide rules and petticoats . . . what a combination! Incongruous? Yet this home economist, who is employed by the Frigidaire Division of General Motors, is involved with each. She wears many "hats" . . . tester, designer, writer, demonstrator. She conducts classes in home economics in schools and companies—teaches how to get the most out of new GM-built household appliances.

She and her counterparts spend full time interpreting the desires, needs and habits of American women in the kitchen and laundry room. Her department, for example, will bake enough cakes to make a stack 125 feet high just in testing a single oven design! In checking a new washer design, thirty tons of clothes are washed. In fact, she's "the voice of women" to the men who engineer and manufacture these appliances.

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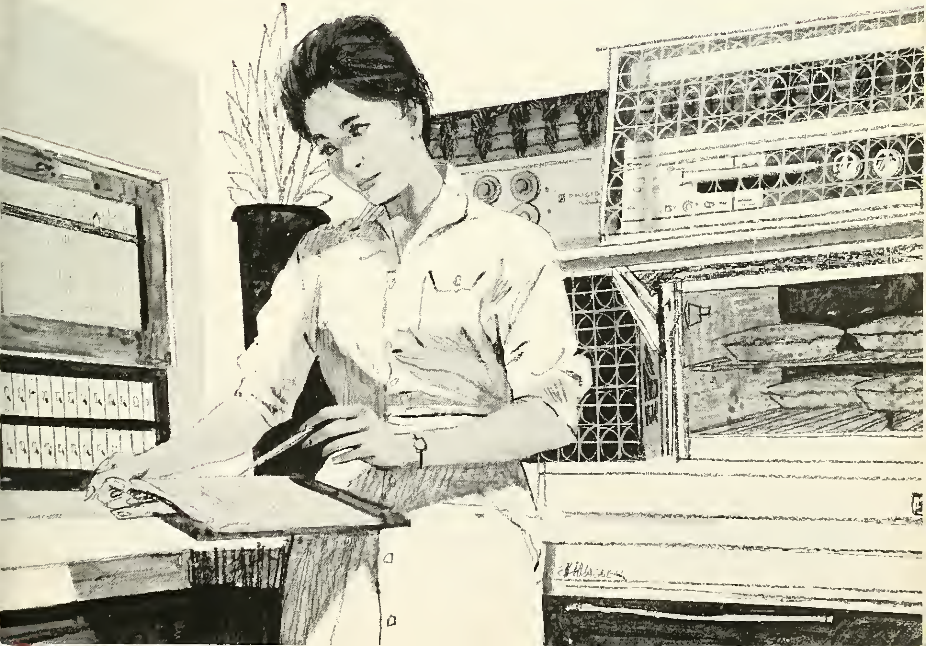

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Reviews

A collection of facts and of controversy

By Ronald Singer

THE ORIGIN OF RACES, by Carleton S. Coon. *Alfred A. Knopf, $10.00; 724 pp., illus.*

For more than twenty years, Carleton Coon collected data in preparation for this magnum opus. The central theme of the book is "to discover how long ago the ancestors of the human subspecies parted company." It is a moot point whether or not its 724 pages have satisfactorily solved this problem.

The impressive list of contents indicates the great diversity of approach and the vast mine of information explored to unfold the mysteries of human prehistory. In that this appears to be the first time such an encyclopedic array of fruitful knowledge has been bound together in the United States, Coon has done science a service. On the other hand, he has done himself an occasional disservice by inflating scanty data to bubbles of fact. Sound generalizations are admirable, but one must be wary not to be swept away by them.

In the first three chapters—"The Problem of Racial Origins," "Evolution Through Environmental Adaptation," and "Evolution Through Social Adaptation"—he often skates on thin ice and now and then he slips through. It will be practicable to list only a few examples of such cracks in the book's structure, as the statement: "A strong flow of blood through that hole [the infraorbital foramen] helps keep the cheeks of the Greenland Eskimo warm. Similarly the size of the mental foramen . . . affects the amount of warm blood that reaches the chin." This displays a romanticism that typified anthropology some thirty years ago. There is no experimental or other factual basis for such conclusions, and it is a pity that the author did not spot these as well as other flaws.

After presenting a series of facts concerning cold adaptation of Lapps, Australians, and Kalahari Bushmen, he then states: "It also confirms my belief that the Bushmen and the Negroes, although they share a continent, are not closely related." This does not follow from the preceding paragraphs (where the Negroes are not mentioned) and furthermore is not substantiated, because it is contrary to the results obtained by th blood groups—the only accurate gen markers available at present. Coon als refers to the *Zinjanthropus* site: "Wha is important here is that crude ston implements as well as bones whic showed signs of being the remains o animals eaten on the spot were scattere there." I would be most interested t learn what these "signs" are. In the sam paragraph, there is also loose theorizin that the fauna indicated that *Zinjanthropus* "had only begun to hunt." Again by stating that children with sickle-cel anemia "may die of oxygen starvation,' he highlights only an intracellular phas of the whole genetic sequence, whic may mislead the reader.

This reviewer, whose special interes is Africa, regrets that Dr. Coon has see fit to revive Broom's *Capoids*, a term tha many have tried to forget and to exclude from the morass of confusing terminology already in use. Furthermore the term suggests that somewhere ther were "Capians"—who? where? when?

It is not very clear at whom this volume is aimed. It is certainly too technica for the average layman, and yet is to scanty in some parts and too dramatize in others for the graduate student, although both layman and scholar can fin some meaty pages.

In summary, although this book contains some glaring errors (even to inaccuracies in spelling and references) and idle speculations, there is also a mass of varied and useful data. It is easy to track down the errors and to query the interpretations, but few could have done better than Carleton Coon in telescoping vital ideas from many—som even rather unrelated—fields of interest. Despite the criticisms expressed above and many others, which neither space nor discretion permit, I enjoyed reading the book. It undoubtedly constitutes a valuable and stimulating core of knowledge that should be read by all interested in man's past and the origin of races.

DR. SINGER, who is an anatomist and a physical anthropologist, is on the staff of the University of Chicago.

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DUTTON

MANKIND EVOLVING, by Theodosius Dobzhansky. *Yale University Press, $7.50; 381 pp.*

A distinguished geneticist, who up to now has focused his attention mainly on the fruit fly, Dobzhansky here turns to man. With the insights gained from population genetics, he has examined man as an evolving biological organism. But man's evolution is peculiar in that it involves his culture as well as his physical environment. This has necessarily led Professor Dobzhansky to explore the anthropological backgrounds of his subject, which he does with considerable skill and judgment.

In the course of the book, Dobzhansky touches on an extraordinary variety of problems and facets of his main theme: human evolution. Genetics, nature-nurture, health and disease, intelligence, race and culture as a selective agent—to name a few—are dealt with. To all of them he brings a sharp, incisive mind and, in most cases, leaves the subjects in sharper focus than he found them.

If here and there the anthropological background is thin, it must be remembered that the point of view is primarily genetic, that the range is amazingly broad, and that space is limited. It is a bravura performance that anyone will find stimulating and exciting to read.

HARRY L. SHAPIRO

INCIDENTS OF TRAVEL IN YUCATÁN, by John Lloyd Stephens. *University of Oklahoma Press, $15.00; 2 vols., illus.*

JOHN LLOYD STEPHENS actually lived the romantic dream of archeology. In fact, his writings are probably responsible in part for the dream itself, for he was a great pioneer in American archeology and had those experiences that so many imagine is the usual lot of the archeologist. Stephens traveled twice to the then unknown regions of Central America and southern Mexico, where he endured many hardships and dangers, but where he literally discovered the ancient civilization of the Maya. Pushing through the overgrown jungles, he found scores of forgotten, partially preserved ruins into which he could walk to explore their mysterious rooms and passageways. Moreover, he came back to New York after each of his journeys and wrote books that were eminently successful and quickly sold a large number of editions.

This was back in the early 1840's. Several Maya ruins had become known through the work of earlier travelers, but it was Stephens and his remarkably talented artist-companion, Frederick Catherwood, who found a good portion of the important sites. These they described and illustrated with a facility and accuracy that has seldom been

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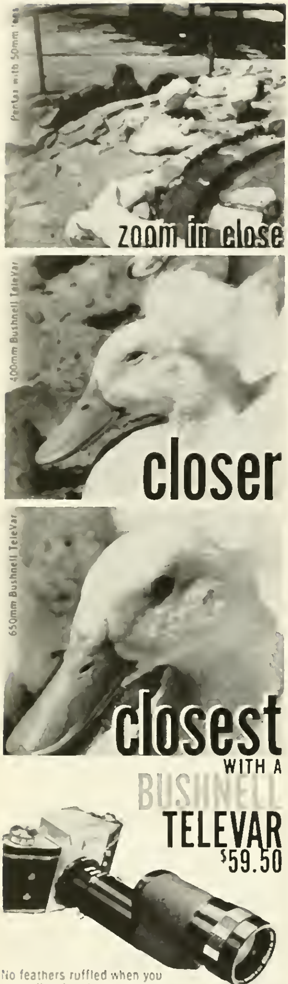

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equaled in American archeology. That they lived in a romantic age is apparent in their work, but their basically scientific attitudes and methods are evidenced in the fact that their books remain worthy of consultation by today's archeologist. A few of the ruins they visited have yet to be described more completely.

This finely printed new edition of Stephens' second book on the Maya is most welcome, for copies of the original are now difficult to find. His earlier work, *Incidents of Travel in Central America, Chiapas, and Yucatán*, has also been reprinted as recently as 1949 by the Rutgers University Press.

Only minor changes from the original are present in this edition. Some spellings have been modernized, and there are a few new titles at the tops of the pages, but the text and Stephens' appendixes are intact. All of the original engravings are handsomely reproduced and give evidence again of how important Catherwood's illustrations were to the success and significance of Stephens' books. Unlike other artists of his time, Catherwood realized that Maya art was unique and was able to reproduce what he saw. Receptive to "modern" methods, he used a camera lucida, and on this second trip, a daguerreotype apparatus (although it is not stated how successfully he used the latter method to record images that could later be used by the engraver).

Victor Wolfgang von Hagen, who edits this edition of *Yucatán*, has written full-length biographies of both Stephens and Catherwood and he provides a helpful introduction to the book. His footnotes, scattered sparsely through the two volumes, are of far less value. Much has subsequently been learned of the Maya cities of Yucatan, many of which are now reached by paved highways and are visited by thousands of tourists every year. Here, von Hagen had an opportunity to relate Stephens' travels to the modern scene and to make the book more significant to the present-day reader. As it is, there is only a meager attempt in this direction and even the map, labeled as being redrawn from Stephens' original, is inadequate for proper orientation.

Like most archeologist-travelers, Stephens brought home a collection of antiquities from the Maya country and a few of these large stone sculptures from Uxmal and Kabah—now form an important part of the collections exhibited in the hall of Ancient Civilizations of Mexico and Central America in The American Museum of Natural History. Fortunately, they arrived late in New York and escaped a fire that destroyed everything else he collected. This was twenty-seven years before the Museum was founded, and the pieces, known as the "Stephens Sculptures," somehow found their way to an artificial

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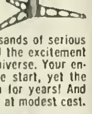

ruin on Cruger's Island in the Hudson River. from which they were recovered by the Museum in 1920. (This event is recorded by H.J. Spinden in NATURAL HISTORY. Sept.-Oct.. 1920.) Being an ardent New Yorker. and a real scientist at heart. it is probable that Stephens would not have desired a better resting place for the things he laboriously transported from Yucatan. One must believe, too. that Stephens and Catherwood played an important role in shaping the social and intellectual trends of the mid-nineteenth century that led to the founding of institutions such as the Museum.

These are but a few of the thoughts that a rereading of Stephens' famous work has prompted. For those who find an interest in archeology and the men and events that brought it into being as one of the great intellectual pursuits of modern times. this book will be a rich and rewarding experience.

GORDON F. EKHOLM

"IN WILDNESS IS THE PRESERVATION OF THE WORLD." selections from Henry David Thoreau; photographs by Eliot Porter. *Sierra Club, $25.00; 72 pp., illus.*

THREE years before Henry Thoreau built his hut beside Walden Pond. he noted in his journal: "Books of natural history make the most cheerful winter reading." The same cheer that he felt more than a century ago will be found by modern readers in turning the pages of this magnificent volume. With Thoreau supplying the text, Eliot Porter the illustrations, and the Sierra Club—a non-profit organization devoted to conservation—publishing the result with the aid of a grant. *"In Wildness Is the Preservation of the World"* is predictably a superb volume.

Essentially it is Porter's book. The large size of the pages gives ample display to the artistic and technical excellence of his color photographs. If there was ever any doubt that Eliot Porter ranks among the world's great artists with a camera, it is dispelled by this volume. Many of the pictures are breath-taking in their beauty. Perhaps the favorite will be the frontispiece, catching, as it does, the richly tinted waters of a stream tumbling over rocks. But close behind are many others. The plate of two luna moths clinging to bracken ferns is one of the most delicately beautiful insect photographs ever made. Few of the pictures depend on artificial illumination. The magic of nature's own lighting glows on pond water or filters down through forest leaves.

Each plate is faced with a quotation from the writings of Thoreau. These are usually brief. Documentary photographs have not been attempted. Rather the spirit of Thoreau's thought has been recorded in the pictures. As Joseph

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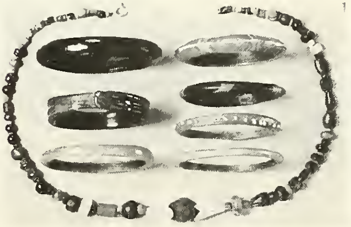

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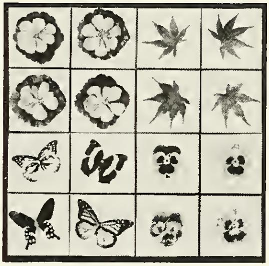

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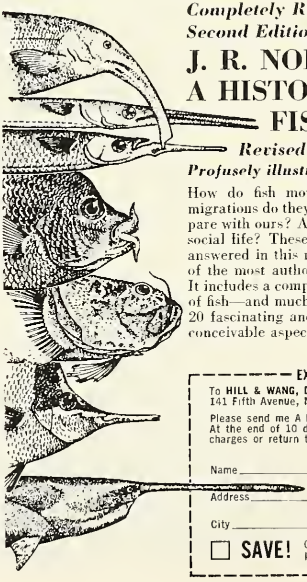

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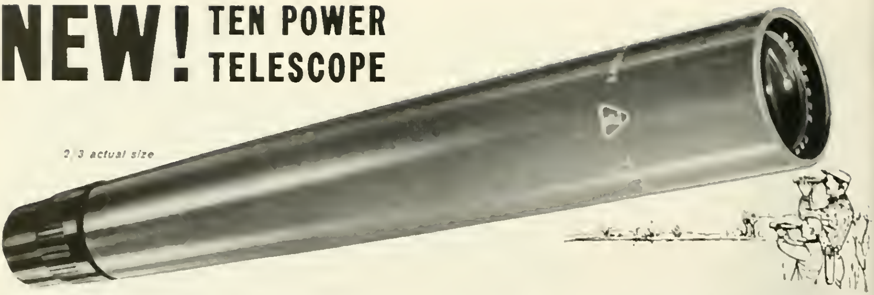

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Wood Krutch points out in his thoughtful introduction, Porter has presented "through the medium of a new art that very world of American Nature which Thoreau, practicing one of the oldest of arts, taught us to see better than anyone ever had before." If Eliot Porter's photographic artistry leads more readers to turn to Thoreau's own writings — to *Walden, The Maine Woods,* and especially to his multivolumed *Journal* this book will prove an important as well as a beautiful milestone in America's attitude toward nature.

EDWIN WAY TEALE

THE COMPLETE BOOK OF NATURE PHOTOGRAPHY, by Russ Kinne. *A. S. Barnes and Co., Inc., $7.50; 191 pp., illus.*

THIS kind of book makes one wish that publishers took their trade more seriously. As a beginning they might stop calling such books "The Complete. . . ." If there were a complete book on such an expanding subject as photography, it would be incomplete by the time it came off the press. This one can lay no claim to being even comprehensive.

I suppose there is room for doubt whether there actually is any organized body of information that could be called "nature photography." Nature is all-enveloping, and photographing it involves virtually all of photography. Many nature photographers are interested only in one or another special field (birds or underwater pictures), and they tend to be more interested in the subjects than they are in the photographs. In extreme cases this leads to the development of ridiculous "rules" (both feet of a bird must be visible; an animal must always have its head up) that are fatal to serious nature photography, just as the "laws of composition" have been to pictorial work. It would be a good thing if more serious photographers were encouraged to study and photograph nature with open minds; there is much to be learned from it.

In trying to cover everything, this book emerges as a miscellaneous collection of handy hints, some of which are very useful indeed. We learn that amphibians can be made sluggish and tractable by cooling them in a refrigerator; that insects can be anesthetized with carbon dioxide; that a common mousetrap can be bent into a remote-control device for tripping the shutter of a camera. The author is an accomplished "gadgeteer," and the text is enlivened with descriptions and photographs of numerous ingenious marvels he has made from tin cans, cellulose tape, paper clips, and plastic. In fact, it is on this level that the book can be sincerely recommended.

In an introduction, Roger Tory Peterson says he plans to take this book "to the ends of the earth" as an essential part of his field pack. Apparently the publishers, too, consider the book valuable for reference, yet they have not bothered to provide an index. This irresponsible attitude pervades the entire book. It appears that the publishers could not decide what sort of book it was to be—a collection of fine nature pictures or a manual of practical information. By trying to do both, they succeeded in doing neither.

In fact, the book bears all the earmarks of having been thrown together in a hurry. Surely an intelligent editor would have caught such nonsense as the statement that "Color transparencies for projection should be a shade darker than those for reproduction, and vice versa . . ." or the description of some bushes that stand hip-high to a caribou as "tundra." A bit more experience would have been necessary for an editor to question the author's unqualified endorsement of certain of the cheaper cameras and lenses, ones that most professionals consider less than adequate, or to notice that in his enthusiasm for the 35 mm. single-lens reflex he has failed to mention some of its disadvantages and has forgotten to cite some of the reasons why other cameras, such as the view camera, may be a better choice for some types of work. Editors with the requisite experience do exist—in fact, they exist within the same publishing house that issued this book, where they produce an authoritative magazine, *Popular Photography*.

If the book had been soundly conceived and edited, half of the photographs would have been eliminated or replaced. It contains 140 photographs (17 of which are pictures of the author looking intrepid in various getups), but it is printed by such a cheap grade of photo-offset that the qualities discussed in the text are unrecognizable in the illustrations. One plate described as "The delicate beauty of Indian Pipe . . ." looks like an X-ray. Some of the pictures are excellent, marred only by the poor reproduction. Others are terrible. Among the worst are three blurred flash pictures of deer, taken by a camera trap. They illustrate nothing but that a fast shutter speed is not sufficient to stop a running deer. A caption states that electronic flash would have stopped the motion, but curiously there is no picture to support the assertion.

Toward the end of the book there is a full-page picture of a pyrite crystal, marred by multiple reflections in the supporting glass. The caption says that

e reflections could have been spotted
airbrushed out. yet the author did not
ve enough respect for his readers to
so or. better yet, to reshoot the pic-
re properly without the reflections.

Obviously. no one photographer can
expected to have good pictures of
erything. Therefore, common sense
ggests that a picture book be a col-
ction of the best examples of work in
fferent fields of nature by different
otographers and printed to preserve
e excellence of the pictures.

If, on the other hand, it is meant to
a practical handbook, a few of the
st pictures would be sufficient for
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d its fairly high price are to be re-
etted. because there is a need for a
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otography in the field. This manu-
ript could have provided one had it
en prepared and presented with care.

David Linton

OLUTION, by Ruth Moore. *Time, Inc.,*
.95; 192 pp., illus.

HIS splendid book on the central
theme of biology alternates eight
apters by Miss Moore with striking illustrative sections prepared by the editors of *Life*. Early chapters outline the development of Darwin's ideas that resulted from observations made on the voyage of the *Beagle*, and the way in which his investigations eventually were drawn together in *The Origin of Species* is presented informatively and well. The field of genetics, a subject unknown to Darwin but which has since proved vital to his theory. is discussed next, followed by a disproportionately brief section on fossils other than those of primates. in which the giant dinosaurs are given their customary overemphasis (40 per cent of the available pages). The remaining chapters are concerned with primate evolution and the origin of man, the latter a subject to which Darwin devoted but a single sentence in *The Origin of Species*, but later dealt with in *The Descent of Man*. The evidence that has led to general recognition of most of Darwin's theory as fact is largely the product of the present century. not Darwin's, and I cannot help imagining how much Darwin would have appreciated the abundant modern documentation so ably displayed by this book. The bibliography is up to date. the index useful, and the illustrations and their captions handsome and truly informative. The book is a beautiful as well as a thought-provoking addition to anyone's library.

Malcolm C. McKenna

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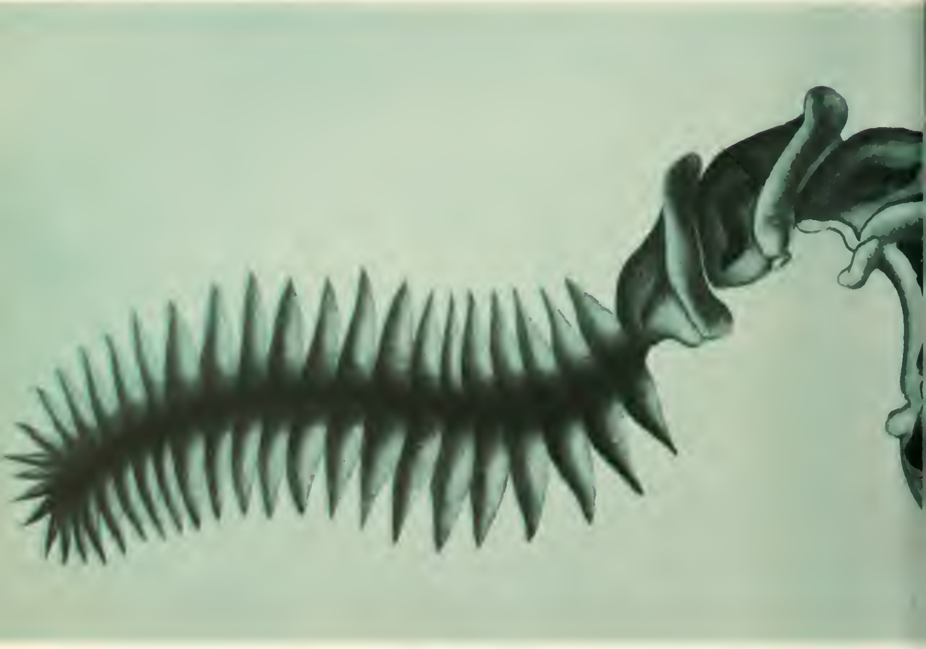


By Meredith L. Jones

It is amazing how little one sees even when one looks. At the shore, for example, an observer can see the surf running up the smooth sand of a beach; he can see holes and cones on the surface of a sand flat or a mud flat at low tide. But he may be totally oblivious to the tremendous numbers of animals living out their kinds of lives beneath the covering layer of the substrate. A frame of window screening, a small quantity of apparently lifeless mud, and a gentle sieving will suffice to open up a vast new world. A single quart of bottom material may contain as many as forty or fifty species of animals, and these may represent more than half of the recognized animal phyla.

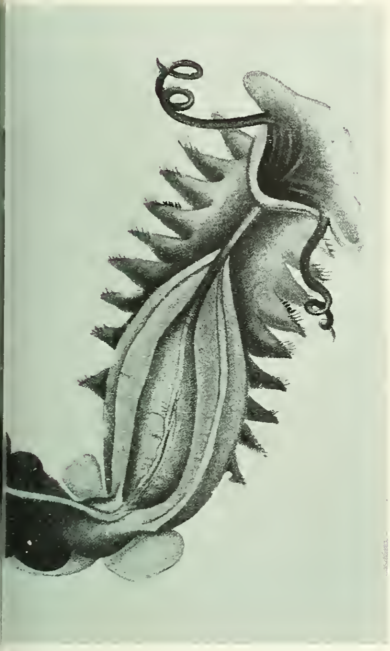
Even without the aid of a lens or a microscope, it is immediately obvious that one type of animal predominates, not necessarily in size, but certainly in the numbers and kinds of individuals. For the soft mud bottom is the habitat to which the marine worms are best adapted and in which they have evolved to take advantage of nearly all of the many possible microhabitats that are available.

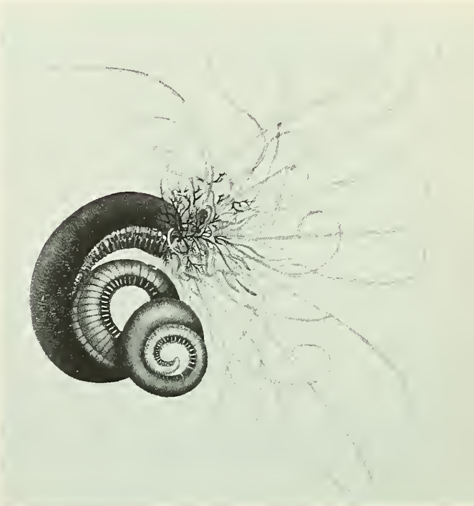
Apart from the basic vermiform shape, morphological differences among the marine worms reflect their specific ways of life. The forms that move about over the surface of the bottom are well provided with anterior sensory structures and prominent lateral appendages; those that burrow through the substrate, where protruding structures might be a handicap, have a much simpler head region and rather insignificant lateral appendages; and those that live in tubes and do not forage extensively for their food have a head region that lacks sense organs but may be provided with a complex food-gathering organ. The primarily carnivorous marine worms are equipped with heavy jaws; those that feed upon the substrate in which they live have a bag-like extension of their alimentary tract that is provided with papillae to which food and sand particles stick; those that derive their nutriment from the surrounding sea water have highly specialized filtering organs; and those that feed on particles of organic debris from the surface of the sea bottom have tentacles that select individual bits of food.

In spite of the great diversification of structure among

Substrate

Diversity of marine worms reflects many ways of life





Terebellid, ***above,*** **is a sedentary worm with short, dark, anterior appendages that are respiratory branchiae. Longer appendages are tentacles used for feeding and tube-building.**

Also sedentary is *Chaetopterus,* shown out of tube, *left.* Tentacles are at mouth, behind which are winglike, mucus-secreting membranes. Modified parapodia are in mid-area.

he marine worms, they are united by a number of morphoogical characteristics. Basically, they are all classified in he phylum Annelida, which is comprised of a number of vormlike animals, all of which exhibit a pronounced segnentation of their bodies and possess a ventrally located ierve cord. The phylum can be separated into five classes: he three most familiar of which are the earthworms (class)ligochaeta), the leeches (class Hirudinea), and the marine worms (class Polychaeta). The latter are particularly listinguished by having separate sexes.

In order to understand the functions of the diverse structures of the marine worms, we must first understand the construction of the animal and something of how various species fit into the biological hierarchy.

In essence, a worm is a fluid-filled, double-walled cylinder. The outer wall consists of an external cuticle and internal muscles, circular and longitudinal. The inner wall is comprised of still more musculature surrounding the alimentary tract, which begins with a mouth and terminates with an anus. The space between the two cylindrical layers is the coelom, a cavity that can be traced back to an early stage in the development of the worm. In most of the other coelomate groups, this cavity is not nearly so well developed as in the annelids, where it is perhaps the most important morphological feature. It is the major supporting system of the worm and is basic to locomotion. It functions as part of the excretory and reproductive systems, and in most cases it plays a part in the feeding process. It also frequently doubles as part of the circulatory system. In short, it is the central structure about which nearly all annelid evolution has taken place.

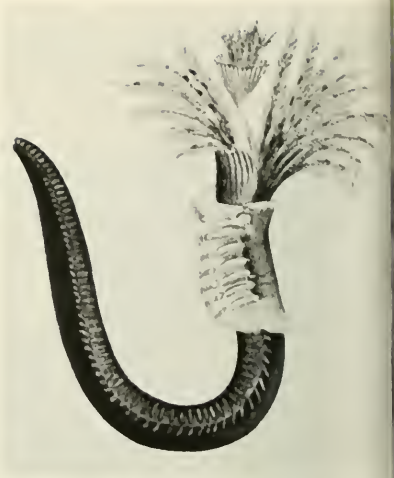
The coelom is divided into a large number of small compartments, or segments, each sealed off from its neighbor by transverse septa. With the exception of those in the most anterior and most posterior regions, each segment is identical to all others. Certain internal structures pass along the length of the worm, but in each segment there are lateral branches of the dorsal and ventral blood vessels, which are the major circulatory structures and lateral branches of the nerve cord, as well as ganglia, or concentrations of nerve cells. Each segment may also contain paired nephridia, which are the excretory or osmoregulatory organs, reproductive structures, and a complete set of muscles—longitudinal for shortening the segment, circular for constricting, transverse for narrowing, and oblique for flattening. Finally, externally, each segment almost always has bristle bundles that aid locomotion.

The repetitive pattern of the middle segments is lost in the anterior regions. Here, as in other bilateral animals, there is a tendency toward the formation of a head, a structure in which there is an opening to the alimentary tract and a concentration of sensory elements. The mouth opening is usually associated with a protrusible organ, the proboscis, which can be extruded by the hydrostatic pressure of coelomic fluid compressed by certain muscles. Contraction of other muscles retracts the everted proboscis, which may be smooth, glandular, or provided with various kinds of teeth, ranging from tiny denticles to heavy jaws.

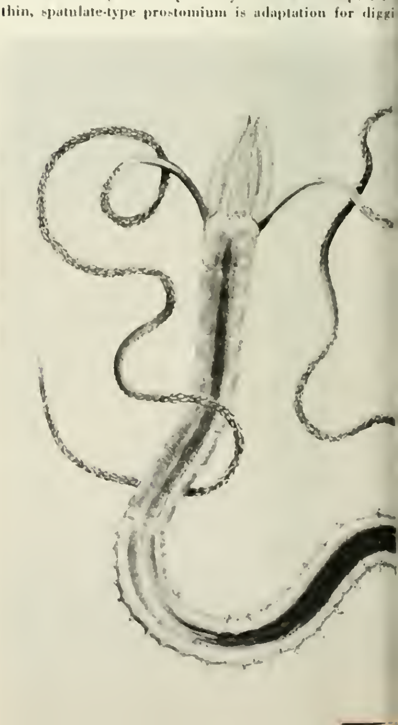
Sense organs and the "brain"—which represents the fusion of several ganglia—are located in the prostomium, a flap of tissue that lies in front of the mouth opening.

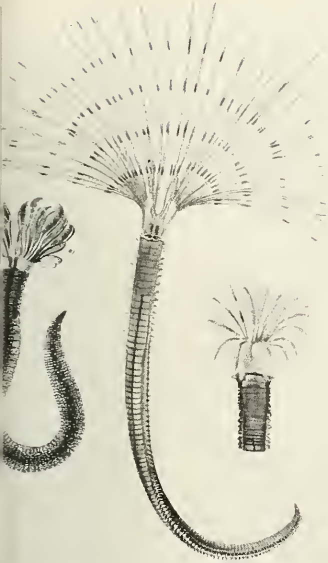
In contrast to the relatively smooth series of segments that characterizes the body of earthworms, the segments of marine worms usually have lateral extensions of the coelom. In their most generalized form, these consist of two pairs of lobes, one dorsal and one ventral, on each segment. These appendages are the parapodia, or "side feet," and their primary function is that of locomotion. Secondarily, they increase the respiratory surface of the worm. While they themselves are somewhat paddle-shaped, their locomotory efficiency is increased by the stiltlike use of bundles of bristles called setae, or chaetae, which project from their lateral margins. The shape of a given parapodium is maintained by internal tissues and the hydrostatic pressure of the coelomic fluid, but its movement, forward or backward, up or down, and in or out, is effected by a series of muscles that originate on the relatively stable body wall. These muscles converge, tentlike, on the internal end of a very stout rod, whose outer end is embedded in the tissue of the parapodium's margin. These, the acicula, are of the same material as the setae—each aciculum might be said to represent an extremely large seta.

THE setae, which contribute to the name of the class, are numerous, not only in numbers per parapodium, but also in their varieties of shape, size, and type. Indeed, the presence or absence of certain setae are almost always familial characteristics. Simple setae are single structures, long and slender, tapering to a point. They are also called capillary setae because of their shape and size. More complex setae may be jointed near the tip, and the terminal portion may be attenuated or short and sickle-shaped. In many of the free-living polychaetes, setae are confined to bundles at the tips of the parapodia, but in the tubicolous and most burrowing forms, they are arranged in a single row and, in extreme cases, may completely encircle the body. Many of the tube-dwelling worms have setae that are relatively short and do not project far beyond the body surface. They are used to maintain the worm's position in the tube, as they are strongly hooked or have been modified as a series of hooks. With proper muscular manipulation, these modified setae, called uncini, can be protruded and the hooks set into the inner walls of the tube. This makes it impossible to dislodge the worm, and its forced withdrawal inevitably results in breakage. As mentioned above,



FAN WORMS are distinguished by their feather-like plun
Serpulid, *above*, builds a calcareous tube, and sabell
right, have membranous tubes. Magelonid, *below*, appe
to be related to *Chaetopterus*. Its elongated palps may
used for feeding and are probably also chemoreceptors.'
thin, spatulate-type prostomium is adaptation for diggi





the tubicolous forms do not possess well-developed parapodia; rather, the setae (uncini and "hooks," in this case) are located on segmentally arranged, padlike swellings, the tori. Each uncinus may have a single large tooth with a series of smaller teeth, and is called an avicular uncinus, owing to the resemblance to the profile of a bird. Some carry one or several rows of teeth of approximately equal size, and are called pectinate uncini, because of the comb-shaped tooth area *(see drawing, p. 16)*.

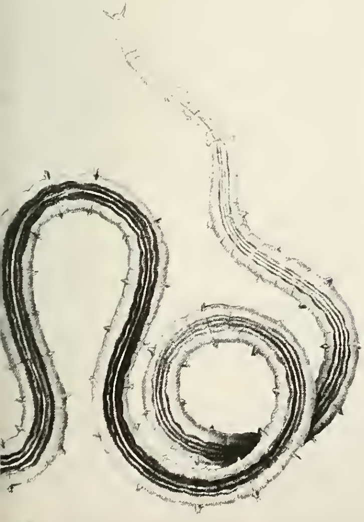
THE setae, because of their tremendous variations, are valuable aids to the taxonomist. Presence or absence of a setal type operates at the familial and generic level, and consistent differences in the relative size and number of teeth, for example, might serve to separate species.

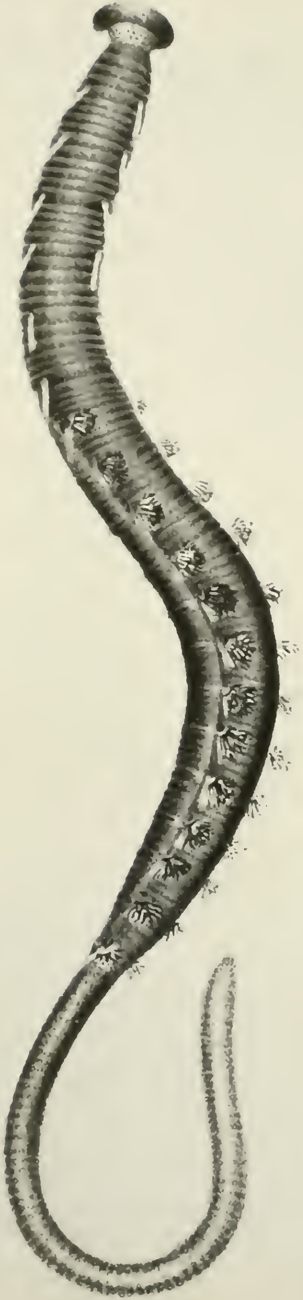
It should also be pointed out that certain setal types are only found in adult polychaetes. In one family, the Syllidae, extremely long capillary setae develop as the males and females become reproductive, while in the Nereidae, compound setae with flattened, paddle-shaped tips are found. Both of these types are adaptations that allow the mature worms to leave their normal habitat, in or on the bottom, and congregate at the sea surface in large swarms. At the proper time, the females release their eggs and the males their sperm, either through formed genital ducts or merely by the rupturing of the body wall. Almost invariably the genital products are thus shed freely into the sea water, for there is virtually no internal fertilization among the polychaetes. While suspended in the water, the fertilized egg undergoes a development similar to that of certain mollusks and ultimately gives rise to a larval form known as a trochophore. This, as well as the presence of a coelomic cavity, indicates a rather close relationship to the mollusks, where similar trochophore larvae are found. The polychaete trochophore undergoes elongation and segmentation and ultimately descends to the bottom, where it continues its growth and differentiation.

Not all polychaete reproduction is sexual. In certain groups, notably the syllids, an adult worm may develop an incipient head in its mid-region. After a time, a new individual differentiates from the posterior portion of the original worm and moves along in tandem *(see drawing, p. 15)*. Further differentiation may take place, so that ultimately as many as four or five individuals might be observed, each attached to its fellows, the whole group moving like a train for a few weeks until the individuals separate. In other syllids, there may be a lateral budding off of single individuals, while in other families, an adult might fragment into several pieces and a new individual develop from each of the fragments. Indeed, there are instances where a single segment has been observed to form a complete new worm.

As mentioned above, the morphological differences between polychaete families are so great that one is hard-pressed, in most cases, to relate them. In general, the differences appear to be adaptations for survival in specialized habitats, for the obtaining of specific food materials, for locomotion, or for protection.

The Syllidae, for instance, are often very small polychaetes, and in some species mature adults may be as short as 2 to 3 mm. in length. Frequently, they are brightly colored and many are provided with a dainty filigree of dorsal processes. Here, the prostomial appendages and the dorsal cirri—tentacle-like extensions of the dorsal margin





of the parapodia—have the appearance of minute strands of beads. The syllids usually live in the material on the surface of the sea bottom, whether it be an algal mat, thick colonies of ascidians or bryozoans, or unconsolidated debris. Often, as in the case of *Haplosyllis spongicola* members of the Syllidae are found in great numbers in the canals and channels of various sponges. It is in this group that asexual reproduction has been most highly developed.

The Nereidae, because some species are used as fish bait, are among the most familiar polychaetes known to the non-biologist. Depending on the locality, they are called "rag worms," "piling worms," "sand worms," "mussel worms," or "clam worms." The nereid prostomium is provided with a pair of palps (probably chemoreceptors), a pair of smaller, centrally located tentacles (probably tactile receptors), and two pairs of eyes. The segment to which the prostomium is attached also bears the mouth opening and, thus, is the peristomium. The protrusible nereid proboscis is armed with a pair of stout jaws that fasten upon the food material and draw it back into the alimentary tract as the proboscis is withdrawn. Often the surface of the proboscis is strewn with smaller denticles, so-called paragnaths, that may aid in shredding the food. Reproduction among the nereids is usually sexual, although one species, *Nereis limnicola*, is known to be a self-fertilizing hermaphroditic form, which retains the developing eggs in its coelomic cavity. When the young are liberated, they pass through the ruptured body wall of the adult and are spawned alive. In other nereids a most amazing example of redifferentiation may be seen. Here, the sexes are separate, and both males and females, as they reach sexual maturity, undergo modifications that are so different from the non-mature adults that they were, at one time, thought to represent a new genus, *Heteronereis*. Now it is known that these forms represent stages in the life cycle of *Nereis*, and the term "heteronereis" is reserved for these sexual phases. In the development of a heteronereis, in addition to the rapid formation of mature eggs and sperm in the coelomic cavity of the middle and posterior regions, the prostomial eyes and antennae become much larger. The parapodia of the anterior region remain unchanged, but the remaining parapodia become flattened and foliaceous. The dorsal cirri become elongated and develop vibration receptors, and the usual sickle-shaped compound setae are shed and are replaced by special paddle-like compound setae. Internally, the alimentary tract, the septa, and the musculature of the body wall all undergo a cellular breakdown, resulting in the conversion of the middle and posterior segments into a single cavity that is filled with eggs or sperm. Subsequent to the completion of this sexual metamorphosis, some unknown factor or factors, probably correlated with the intensity of moonlight and the phase of the moon, initiates swarming of the heteronereis forms, and they leave their burrows and galleries to swim to the surface of the water, aided by the modified parapodia and setae. They orient to one another—by the vibration receptors of the cirri, and perhaps by the chemoreceptors of the prostomial appendages—congregate, and eggs and sperm are liberated by the rup-

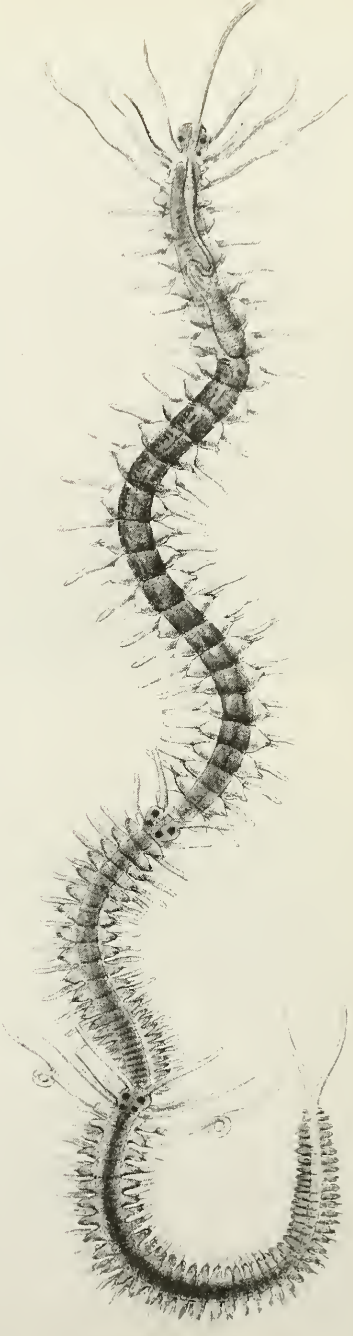
MUCUS-SECRETING papillae are almost visible on digging proboscis of *Arenicola*. Branchiae appear on sides as tufts.

turing of the thinned body wall. The fertilized eggs develop further, floating as a part of the plankton, while the adults sink back to the bottom, where they either regenerate new posterior regions or die.

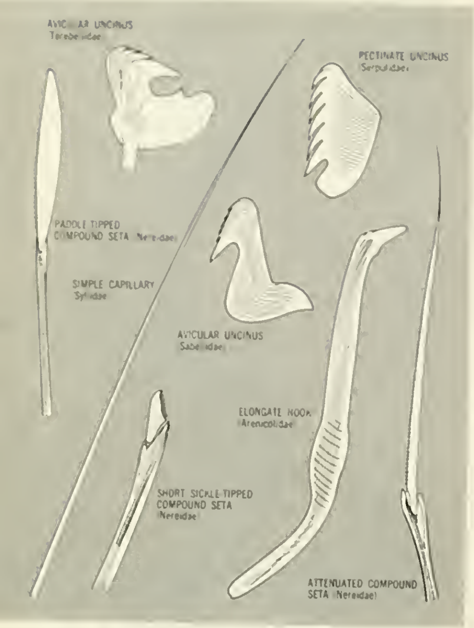
A final point to be made concerning the Nereidae, is their success in penetrating into fresh water. More than fifty species are described from fresh water and diluted sea water. One of these was collected from a fresh-water stream in the Sierra Lagunas, Baja California, at an altitude of 7,000 feet above sea level! Further, seven species of "terrestrial" nereids are reported from the humid islands that comprise Indonesia.

Another polychaete family best-known as fish bait is Glyceridae. These, the bloodworms, are usually found in a mud environment, through which they move with the aid of the rather long proboscis *(drawing, p. 17)*. This is everted, and its movement causes the sediment particles to become suspended in the interstitial water. When its movement stops, the particles, in effect, settle, and the substrate becomes firm. Then, when the proboscis retractor muscles are contracted, the body of the glycerid is pulled forward. In addition to its locomotory function, the proboscis of these slender, attenuated worms also acts as a food-getting organ, and the four large jaws at its tip function in the same way as those of the nereids. The general red color that gives these polychaetes their common name is due to the hemoglobin of the coelomic fluid. There is no "blood," per se, in this case, for there are no formed circulatory vessels. The internal fluid of the glycerids acts as a respiratory liquid. Its circulation is entirely random and is accomplished by the general body movements of the animal. The prostomium of the glycerids is elongate and its only appendages are four minute tentacles at the tip.

Several other polychaete families live out their lives moving through the mud and sand of their environment. For the most part these are not carnivorous like the glycerids, but feed in the same manner as the familiar earthworms. These, the deposit feeders, ingest great quantities of the substrate through which they burrow and utilize the bacterial film and interstitial organic detritus or debris mixed with mud and sand particles. The Arenicolidae have rather poorly developed prostomia; palps, antennae, and tentacles are entirely lacking. *Arenicola*, the lugworm *(shown on p. 14)*, lives in a semipermanent burrow, which is open at times to the surface of the sand or mud flat in which it lives. Most of the time *Arenicola* is to be found at a depth of from six to twelve inches below the surface, "eating" its way through the substrate. Its proboscis is provided with mucus-secreting papillae to which substrate particles adhere, and ingestion takes place as the proboscis is withdrawn. Obviously, most of the material taken in by the worm is indigestible, and at approximately half-hour intervals *Arenicola* backs up its tube, evacuates the undigested material as a continuous casting, and then uses the last bit of casting to plug up the opening of the burrow. The worm then returns to the lower level of its burrow to begin feeding again. As it feeds in the same general area, a space is continually hollowed out and, ultimately, the overlying material slumps down, providing more food.



In asexual reproduction of *Autolytus*, new individuals are formed along mid-section, swim in tandem, then separate.



GREAT VARIETY in setal types makes them taxonomic aids. Size and number of teeth might serve to identify species.

Thus, *Arenicola's* presence can be determined by coiled castings and a conical slump area a short distance away.

A number of other polychaete families also feed on organic detritus, but in these cases the food material is suspended in the sea water. In order to utilize this, various methods of filtration have evolved. *Chaetopterus (drawing, p. 10)* lives in sand in a U-shaped tube that has narrow openings at each end, both of which communicate with the overlying water. The dorsal part of the middle region of this polychaete is modified as a series of pumping and filtering structures. Near the head, a pair of parapodia are modified as elongate, mucus-secreting organs. These structures are long enough to meet dorsally when they are pressed against the side of the tube. Mucus is secreted on the inside of the winglike appendages and is pulled posteriorly along a ciliated groove to form a long bag. The groove terminates in a small, ciliated, cuplike structure that rolls the end of the bag into a mucous ball. Posterior to the ciliated cup, three pairs of parapodia are fused medially to form dorsal, fanlike structures, whose rhythmic beating creates a flow of water in the tube. Fresh, unfiltered water passes in through one of the tube openings, is filtered against the mucous bag, and passes out the other opening. The filter produced by *Chaetopterus* is extremely fine; it has been demonstrated that large proteins may be retained by it, and it has been estimated that the mesh openings must be about 10 angstrom units in diameter (1 millimeter = 10,000,000 angstrom units).

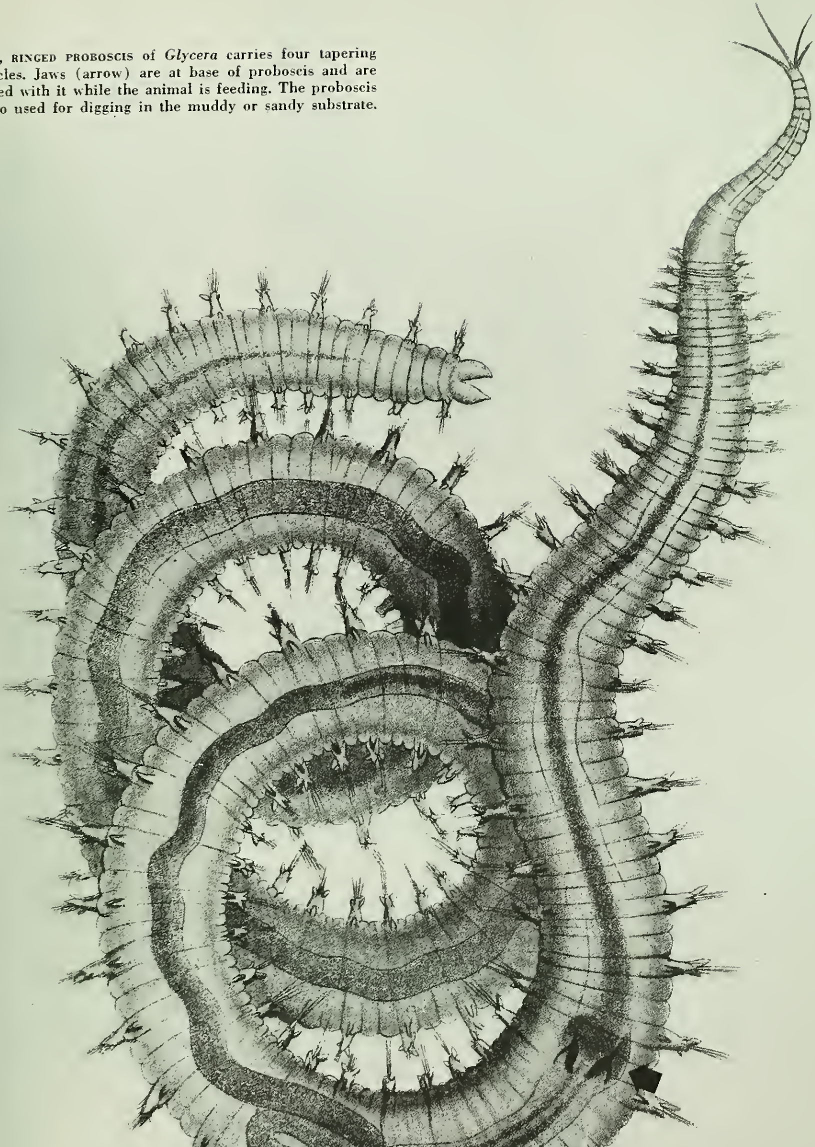
Two other polychaete families that filter suspende detrital material are the Sabellidae and the Serpulida Species of both of these groups live in blind tubes, ope at one end, and project from the open end while feeding They are provided with a so-called branchial fan, or crow which is made up of a number of branchiae, each wit ciliated lateral appendages along its length. The beat o the cilia is such that a water current is maintained acros the branchiae and suspended particles are caught by th cilia. There appears to be no initial selection of the material trapped by the cilia, but it has been shown that, at leas in the case of the Sabellidae, there actually is a selectiv mechanism built into the basic structure of the branchia crown. The finer material goes directly to the mouth wher it is utilized as food. Medium-sized material is carried t a pair of ventral sacs near the mouth, where it is store until it is used in the construction of the tube. Coarse material is discarded. Probably a similar mechanism i employed by the serpulids.

Although the presence of the branchial fan in bot the Sabellidae and the Serpulidae makes for a similarit of appearance *(see pp. 12, 13, top)*, there are a numbe of differences that separate them as distinct groups, on of which is habitat. The serpulids require a hard substrat for the attachment of their tube, but the sabellids can liv on a soft mud bottom or in crevices between rocks.

As the last example in our cursory consideration of the morphological diversity of polychaetes—bear in mind there are approximately sixty more families—we find that the Terebellidae *(drawing, p. 10)* are also detritus feeders. Their source of food, however, is the debris found on the surface of the sea bottom. Like the sabellids and serpulids, their prostomium is reduced to an insignificant ridge on the most anterior segment, and is usually obscured by the numerous threadlike tentacles that arise from it, each of which is provided with a ciliated groove. The mass of tentacles are the feeding organ of the terebellids, as well as the means of obtaining material for the construction of its tube. When feeding, the anterior end of the terebellid projects from its tube and ciliated tentacles radiate in all directions. Each one acts like an independent finger, extending over the substrate, touching various particles, selecting some and ignoring others. The material selected is picked up in the mucus of the ciliated groove and is moved back along the length of the tentacle to the mouth. When a tentacle has extended to its fullest, it is completely retracted and moves out once again in a new direction. In the same manner, the bits and pieces of shell, sand grains, sea urchin spines, and other debris are collected for the construction of the membranous tube. The basic tube material is secreted from an area just posterior to the prostomial area, and the harder materials appear to be added by the ciliated tentacles for strengthening the tube. In most cases, the branchiae of the Terebellidae are confined to the first few segments posterior to the prostomium. They may be a mass of threadlike structures; they may be regularly branched in one plane or at random; or they may be fuzzy tufts on the ends of bare stalks.

In the close observation of the polychaetes, we undeniably find vistas of strange and delicate beauty. But even more important, we find the beauty of function and the almost limitless diversity of form that reflect adaptations to life in what is, potentially, an inhospitable environment.

ONG, RINGED PROBOSCIS of *Glycera* carries four tapering entacles. Jaws (arrow) are at base of proboscis and are verted with it while the animal is feeding. The proboscis s also used for digging in the muddy or sandy substrate.



FLYING SQUIRREL, ready to spring into a glide, clings high on trunk of tree.

IN FLIGHT, *Glaucomys sabrinus* shows furry underside of gliding membrane.

Night Gliders of the Woodlands

Vociferous *Glaucomys* rarely appears

By ILLAR MUUL and JOHN W. ALLEY

MOST HUMAN ACTIVITY is confined to the daylight hours, and even hough some of us claim to be "night owls," we function primarily under rtificial illumination. Consequently, we have a limited knowledge of most of the habitually nocturnal animals.

Although many persons have heard of flying squirrels or seen photographs of them, actual encounters are somewhat rare. A woods with nut- or acorn-bearing trees, a water supply such as a pond or a stream, and scattered dead trees and snags are quite likely to support a group of these attractive small animals. Sometimes cities conceal a sizable population of the squirrels, which often nest in attics. Their nocturnal activity in such cases can disturb the human occupants.

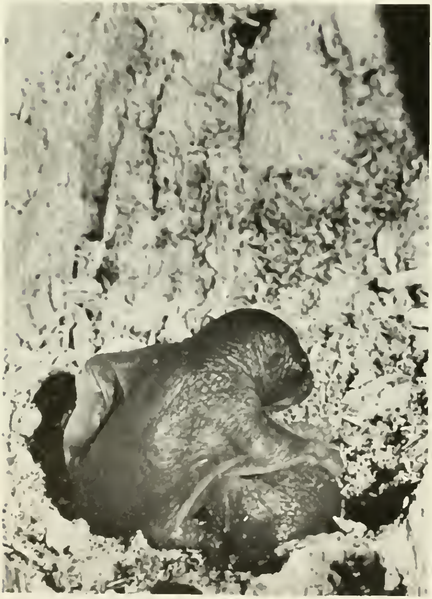
Autumn nights, during which the winter store of food is accumulated, are probably the best times to observe flying squirrels, since it is then that their activity is greatly accelerated. They emerge from their nests half an hour or more after sunset, but later in the evening, when our vision is limited to the cone of light from a flashlight, it is difficult to see them in the trees. At best, one may see a flash of the light underside of the flat, featherlike tail, as the squirrel scrambles to the other side of the tree. The tail appears to go in the opposite direction from the body. This may serve to distract any would-be predator and explain the occurrence of only a partial tail on some flying squirrels. Because they are vociferous, they can probably best be recognized by their high-pitched, excited-sounding "cheeps" heard on moonlit nights.

THE activity of flying squirrels is greatly reduced during cold winter weather. During stormy nights, only a limited amount of time is spent outside of the nest. In severe weather they may come out only for a short time to feed from their winter stores. This food, cached in crevices, crotches, and hollows in trees, may include hickory nuts, acorns, wild cherry pits, and other seeds. Any dormant insects, pupae, lichens, and fungi that may be found during food forays in more favorable weather are also eaten. In warmer seasons, many types of vegetation are eaten: mushrooms, persimmons, serviceberries, wild grapes, the bark of many hardwood trees, and blossoms. If corn is found, starchy matter is always discarded for germ.

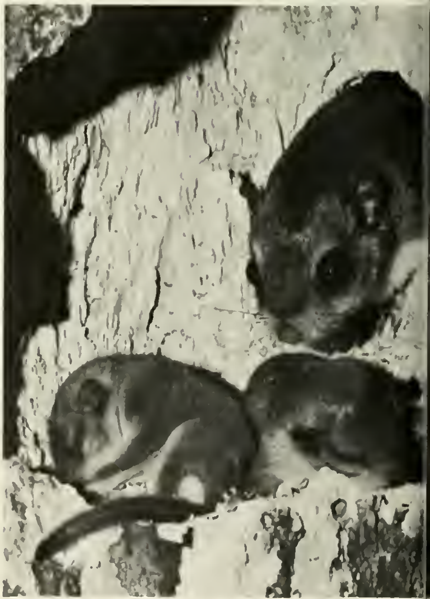
Although flying squirrels do not hibernate, they spend much of the winter nesting together in groups. During extremely unfavorable periods they may enter a state of semitorpidity, and sometimes of complete torpor. Semitorpidity is accompanied by lowered body temperatures and decreased metabolic rates. When in torpor the animal remains curled up even when lifted from the nest, and the body temperature and metabolic rate are markedly lower than during semitorpor. When stimulated by a few minutes of handling, the animal becomes active. It is not yet known how much of the winter the squirrel remains in torpor, but even on a short-term basis it would represent a significant savin of the animal's caloric reserves, whic would otherwise be expended in th maintenance of normal body temperature and high metabolic rates.

In addition, their gregarious nesting habits help to conserve heat by reducing the net surface area of th group exposed to the cold, since th squirrels are in contact and benefi from one another's radiant heat. This coupled with ample nesting materia and the protection afforded by the tre cavity in which they nest, helps t minimize the impact of the cold, whic many small mammals escape by burrowing below the frostline. As many as thirty flying squirrels have bee found nesting together in winter; th average is about four.

Breeding begins in February o March, depending somewhat on th latitude. The northern flying squirre (*Glaucomys sabrinus*) of easter Alaska, Canada, the West Coast mountains and Rocky Mountains to Colorado, the Appalachian forests, and th northernmost states begins breedin later. Among the smaller souther



TWO DAYS AFTER BIRTH, young squirrels are still hairless and blind, but possess well-developed gliding membranes.



FEMALE ENTERS TREE NEST through hole in bark. She keep constant watch over young, which grow fur in second week.

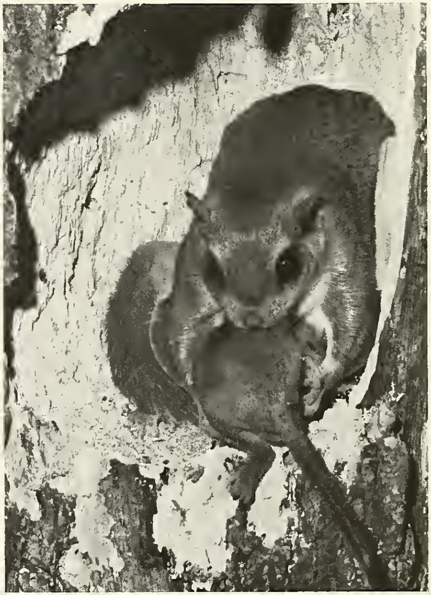
ies (*G. volans*), which ranges ss the entire eastern half of the ted States. the young appear ap- ximately forty days after breeding, about the first part of April in higan. In Kentucky, the first litter orn in the middle of March; far- south, it arrives even earlier. eding may continue into the sum- . resulting in litters in August and tember as well. In most cases, how- , it seems that different females are lved in the fall litter; a few fe- es produce two litters.

HE young of the spring are weaned in the middle of June or when they about six weeks old, although e solid food may be taken earlier. here is no fall brood, the young n during the spring remain with mother. Such nesting groups prob- form the nucleus of the overwin- ng colonies. Thus, a population in mer may spread out and then e together again in the fall.

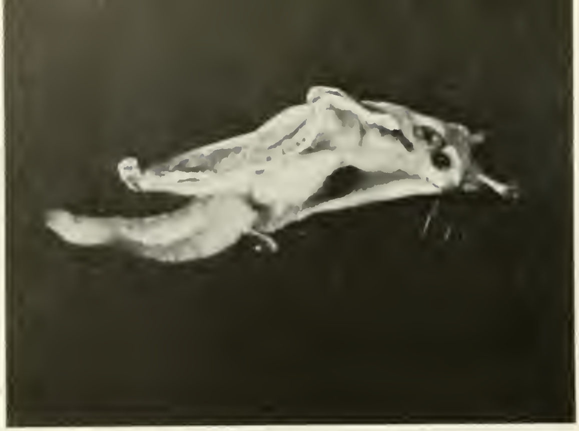
'rior to the arrival of the young, female leaves the winter colony constructs a large nest of finely

Diet of mature squirrels is varied, ranging from nuts, tree buds, fungi, and insects to nestlings and birds' eggs.

t of the nest, but still too weak to glide, young animal nly able to cling to bark, and may need to be rescued.



Parent responds quickly to return her offspring to safety of tree hollow. Open nest was photographed in laboratory.



IN FULL GLIDE, the squirrel maintains its feet and tail in line with its body.

CLAWS EVERTED and body curved, *right*, the animal slows its glide for a landing.

divided inner bark fibers in an old woodpecker hole or some other cavity in a tree. Nests are also built in tree knotholes, birdhouses, attics, and outbuildings. In southern states, outside nests of Spanish moss are constructed or, on occasion, old fox squirrel nests may be renovated.

From two to seven young are born in each litter, the most common number being four. The newly born young are usually less than $2\frac{1}{2}$ inches long from head to tail and weigh about $\frac{1}{5}$ of an ounce. They are blind, pink, and hairless. The gliding membrane, however, is already well developed. The young nurse every few hours and the large intake of food promotes rapid growth. They more than double their body weight between the ages of six and twenty-four days. Soon the nose whiskers become enlarged and the head becomes covered with fuzz. When about a week old the young squirrels' backs become gray as the hair follicles and melanin begin to develop, and before another week passes the back is covered with short, soft fur. Awkward crawling begins at the age of three days and by twelve days the young can cling to objects. As development progresses, co-ordination increases.

THE females are attentive mothers, responding quickly to sounds of distress from the young. When the nest is disturbed, the female picks up her young by the lateral fold of skin in the gliding membrane and carries them one by one to safety. The female has several secondary nests available to which she can bring the young. These are similar to the primary nest—located in a tree hollow—and contain some nesting material. After the safety of the young is assured she returns to the primary nest and gathers up the nesting material, which is then transported to the new location.

She will not waver in her performance of this task—a flying squirrel was once seen moving her young during a forest fire, and being singed in the process. Nor will she hesitate if she is outnumbered or if her foe is larger than she. She will pick her babies from one's hand if they are removed from the nest. At the same time, the young emit high-pitched cheeps that help the female in locating them. When one imitates such sounds, the female can be induced to search through one's clothing for the "hidden" young. Sometimes she will attempt to drive the intruder from the nest by diving at him, each time barely missing him.

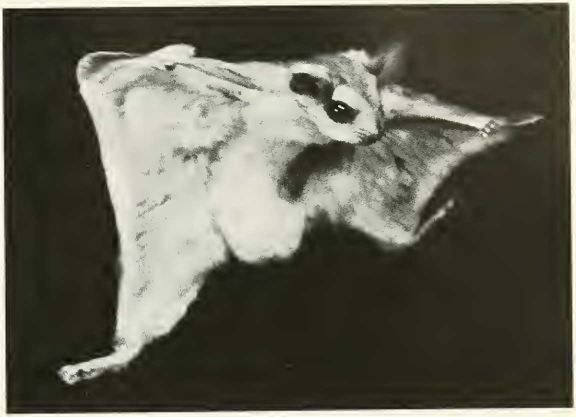
A female's glide of as much as fifty feet does not seem to be greatly hampered by the added weight of even half-grown young. Squirrels older than two weeks cling with their legs around their mother's neck, thus facilitating their transportation. While walking, she holds her head high to prevent the young from dragging on the ground.

Females seem to respond to the young according to age. In one experiment, a mother was presented with one of her own offspring plus one several days younger. In fifteen trials, she almost always picked up the youngest first, which indicated that she did not distinguish her own offspring from that of other females.

The young, too, exhibit an interesting defensive behavior when disturbed. If something enters the nest they will turn on their backs and slap quickly with their feet at the intruder. A strange animal that pokes its nose into the nest may thus be sufficiently startled to retreat.

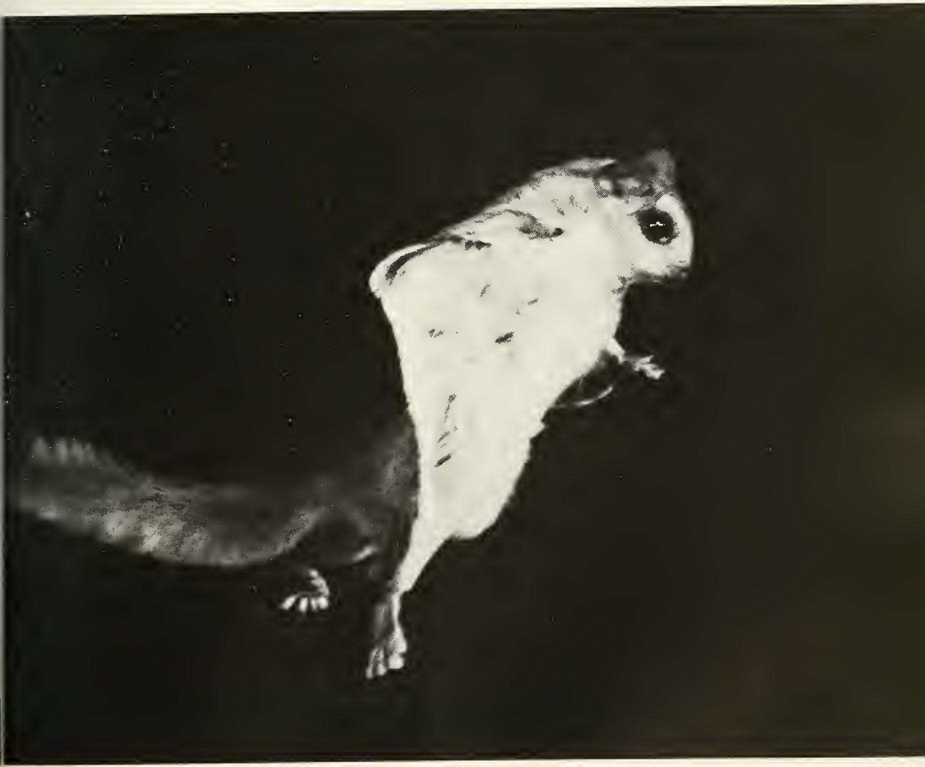
EYES of the immature squirrels open when they are about twenty-seven days old, and soon they begin short exploratory trips in the vicinity of the nest although any disturbance causes them to scurry quickly back to it. Sometimes, if a young squirrel's feeble limbs are not quite steady enough to support it on its elevated perch, the result is an inadvertent trip to the ground. A few cheeps, however will bring the mother to the rescue. Limited gliding is begun at the age of about six weeks, and each attempt may take the squirrel to a branch a little farther from the nest. The leap to the next tree is a bit more difficult, and it takes more time and some coaxing by the mother before the young squirrel will actually attempt it.

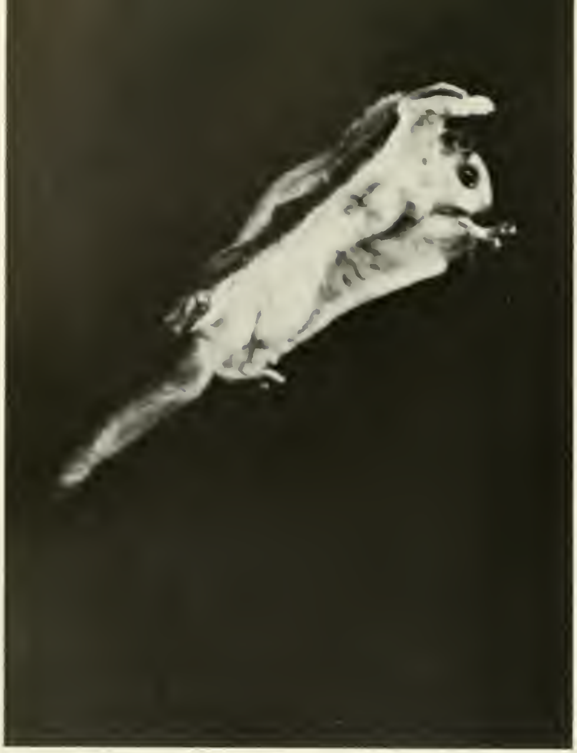
It is surprising how much control the female has in directing the movements of the young once they are able to accompany her. She can apparently signal for them to follow or to remain in a tree while she goes on to explore another. The gliding capabilities of the offspring develop quickly. By eight weeks they can execute 90-degree turns, lateral loops, and other maneu-



Left foreleg, at right, is lowered as squirrel, *above,* swings into a turn.

Squirrel swoops up to land by using gliding membranes as a brake, *below.*





Landing sequence begins as squirrel, *left*, tilts itself up to reduce speed. Claws ready to grip and body arched, *above*, animal settles softly against tree, *below*, at entrance to its nest.

vers that are characteristic of most fully grown flying squirrels.

When about to launch itself into the air, the flying squirrel bobs its head up and down and back and forth several times; this may help to improve distance perception. The squirrel uses all four feet to spring into gliding flight. Occasionally it may keep the gliding membranes relaxed, which allows the animal to drop rapidly for the first part of the glide; then it will assume a normal glide position by spreading the membranes.

Direction of the glide is determined by manipulation of the forearms. For example, a left turn is accomplished by dropping the left arm lower than the right. This creates aerodynamic drag against the right membrane and the squirrel is spun around into a turn. Several turns are sometimes made in rapid succession, and there is little doubt that such fancy aerial acrobatics come in handy when the squirrel is being chased by its most common nocturnal enemy, the owl.

Occasionally the downward slope of the glide follows a spiral path. In this way the squirrel apparently reduces momentum when gliding from a high tree to a spot close to the trunk and near the ground. Spiral glides are accomplished by holding the turn position. The tail may be useful in maintaining balance, but it probably is not essential, since squirrels with only partial tails have been seen gliding successfully from tree to tree.

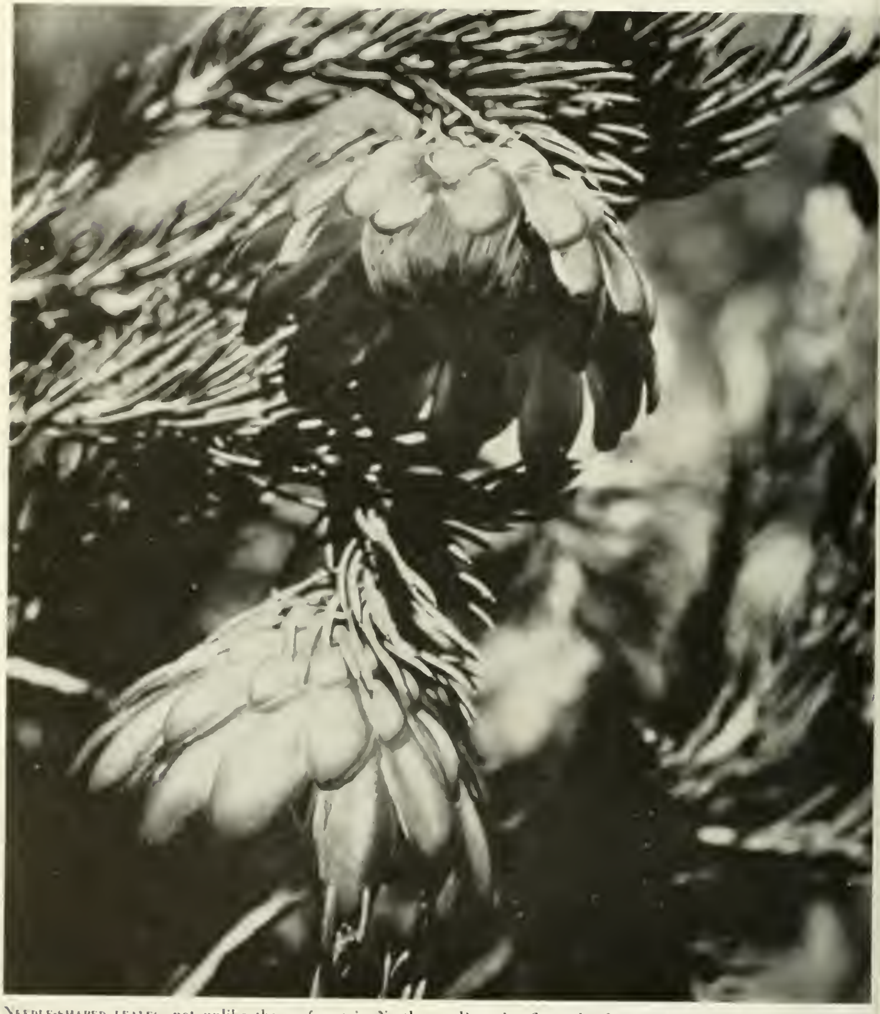
The distance of the glide depends on the height of the take-off point. Glides of up to 160 feet are often made; the record is about 100 yards, attained when a squirrel glided down a steep hillside. Sometimes the animal drops straight down for some distance, then swoops up again, utilizing the gained momentum, and comes to rest high on an adjacent tree trunk.

The landing is soft and silent. As the squirrel turns upward to land, the membranes spread like a parachute. The glide also is silent, much like the flight of an owl. But whatever is gained by this silence would seem to be countervailed by frequent volleys of "chips," "cheeps," and many other characteristic high-pitched noises.

Vocal sound, however, is important to these social animals, since it helps them to keep track of one another and provides a warning system. Sounds produced by flying squirrels sometimes exceed the upper limits of frequencies heard by human ears. Since these are emitted during the glide, it is possible that they are a supplementary device, similar to echolocation in bats. If so, this would explain the great accuracy of the glides—even those made during very dark nights. Unlike those of bats, however, the eyes of the flying squirrel are probably of great importance. Research is now being done on this specific aspect of the animal's gliding capability.

A Floral Inheritance

Proteas of South Africa are kaleidoscopic in form and color



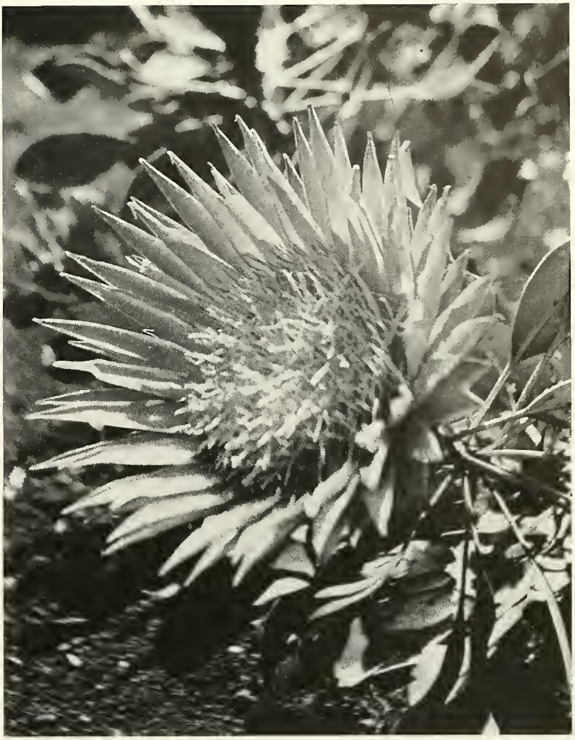
NEEDLE-SHAPED LEAVES, not unlike those of certain North American conifers, distinguish the *Protea witzenbergiana.* Drooping flower heads on this spreading shrub are smaller than are many in the family—about two inches in diameter.

By Elizabeth Scholtz

The choice of protea as the national flower of South Africa is a happy one and should please not only the botanist and gardener but the historian as well. One of the species of this all-South African genus was the first native plant to be recorded by an early seventeenth-century collector, nearly fifty years before the first Dutch settlers came to the country. This was *Protea neriifolia*, described by Clusius as a thistle, although its specific name refers to its likeness to *Nerium*, the oleander. The description was in a volume published in Antwerp in 1605.

Historically important, too, is another proteaceous plant, *Brabeium stellatifolium*, the wild almond. This quick-growing bush, which reminded the Dutch settlers of the almond trees of their native land, was planted by Jan van Riebeeck, the first commander at the Cape, to create a barrier against the marauding Hottentots. Fragments of this massive hedge, established in 1660, are still in existence, and have been declared a national monument. Some are to be found within the confines of the National Botanic Gardens at Kirstenbosch. The trunks and the branches do not appear especially old, as they are not thick and gnarled. This is because the aerial portions have been cut and burned many times, so that now all that shows is relatively new replacement growth. The huge roots, however, reveal the great age of the original hedge.

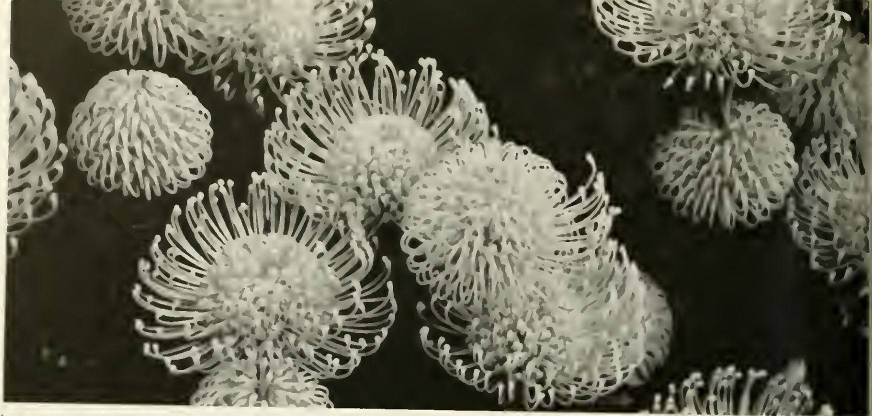
Botanically, the family Proteaceae is interesting in its distribution, and the plants are becoming increasingly popular both in public and private gardens of the Republic of South Africa. This last fact is significant in the plants' future, as many species have been threatened with extinction. Bush fires have destroyed vast tracts of Cape scrub vegetation that is composed of small-leaved evergreens — proteas, heaths, pelargoniums, and composites — all of which are very flammable. In past centuries the arboreal members of the Proteaceae were used as firewood, but the Wild Flower Protection Society has placed all proteas on the protected list, making it illegal to cut the wood and pick the flowers. However, city growth has inevitably meant the sacrifice of much natural bush.



Salmon-pink bracts surround the white head of *P. cynaroides*, or king protea. Nine-inch flower heads are terminal; green leaves of plant are edged in red.

Proteaceae is a family of dicotyledonous plants comprising sixty-one genera and fourteen hundred species. These are by no means confined to South Africa: they are distributed through Australasia, Africa, and tropical America — so broad a dispersal that it is thought by some to support the theory of continental drift (Natural History, April, 1962). *Macadamia ternifolia*, the macadamia nut tree, which is extensively cultivated in Hawaii, is actually native to Queensland, Australia. The fourteen genera indigenous to South Africa are all evergreens and are an important component of the natural vegetation in the southwestern Cape Province. It is in this southernmost tip of the continent that the most showy and beautiful members of the family are found.

The plants are all trees and shrubs, the flowers of which are borne in a composite head. The South African species have flowers that vary greatly in appearance, a fact that led Linnaeus to give the plants the generic name of *Protea* — a reference to Proteus, the mischievous son of Neptune who could change his form at will. Some are like thistles, others resemble pincushions, and yet others bear a strong resemblance to roses. Those of the genus *Protea* are massed together in a cuplike inflorescence, the rim of which is formed of variously and often beautifully colored bracts. They may be silvery-white, green, yellow, all shades of pink, red, and even purple. Because of the stiff nature of the surrounding bracts, proteas make excellent cut flowers, and last for several weeks. They can be sent to flower shows anywhere in the world, and can be purchased at the Jan Smuts International Airport by travelers. As the flowers age, the bracts dry to a rich brown and can be



Low, spreading shrub of *Leucospermum nutans* rarely grows higher than four feet. "Pincushion" shape of yellow-orange blooms is emphasized by central, recurved perianth segments. Flowering season of these plants is extraordinarily long.

Vanishing species is the marsh rose, which has bracts of deep silvery-pink.

Blushing bride is popular name for the magnificent, pink *Serruria florida.*

used in dried arrangements. They are now being cultivated extensively in the Cape Province, but strangely enough New Zealand horticulturists first recognized their value, and proteas are among the favorite flowering shrubs in New Zealand gardens. In the eighteenth century they were familiar plants in British greenhouses, which were then kept warm by heated air and were very dry, but the introduction of steam heat in the nineteenth century was unfavorable to their cultivation.

Of the South African genera there are six that have particularly showy flowers. Chief of these is *Protea* itself. *Leucospermum, Leucadendron, Serruria,* and *Mimetes* are also found in cultivation, and their flowers make handsome arrangements. *Orothamnus,* while very beautiful, is extremely rare.

Although the sugarbush protea is actually the national flower of the country, a number of other species have been used on stamps, coins, and insignia. *Protea mellifera,* the sugarbush of the song ("Sugarbush, I love you so, I can never let you go"), is truly a honey bearer, and the waxy-looking flower heads are usually dripping with nectar that can be boiled to make a pleasant-tasting syrup. This plant once formed bands of bush along the slopes of Table Mountain above Cape Town Harbor, but the destruction of natural vegetation for new housing has caused it to become a rare species in that vicinity. A recent issue of postage stamps features the king protea *(Protea cynaroides),* so called because it has the largest flower heads —up to nine inches across. In giving it the species name, Linnaeus referred to its likeness to *Cynara,* the artichoke.

Sometimes called the "queen" of the genus is *Protea barbigera,* althoug this is better known as the wooll bearded protea — an unflattering description of the queen, which is flower of delicate beauty despite its size and hirsuteness. The surrounding bracts vary in color from pale, silvery green to rose-pink and are covered with a soft down. *Protea grandiceps* has perhaps the most attractively colored flower heads of all—the bracts are a lovely clear coral shade.

These brightly colored bracts point to insect pollination, and bees are frequent visitors to the flower heads. Long-beaked sugarbirds and protea beetles are other pollinating agents. The iridescence of the birds' feathers and the beetles' bodies contrasts sharply with the gay colors of the flowers. The beetles, however, probably are more destructive than beneficial in their forays on the flowers. As many of the species, particularly the leucospermums, have prominent styles, wind is also a pollinating agent.

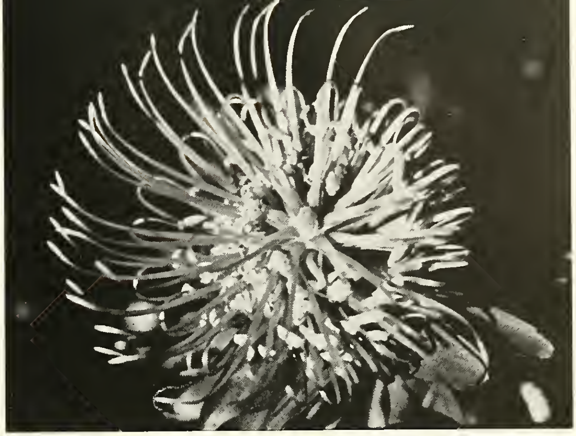
The name *Leucospermum* refers to the distinctive white "seeds" of this genus. These are actually whitish, nutlike fruits, produced on flower heads that look like pincushions. The brightly colored flowers are not surrounded by bracts, and the long, showy styles are bent double until they ripen, when they become the "pins" on the pincushion. These remarkable flowers often bloom from the beginning of winter to the beginning of summer. *Leucospermum reflexum* (the tallest plant with reddest flowers) has flower heads in which the styles hang down. In *Leucospermum catherinae*, the styles turn in a clockwise direction and look like wheels.

THE famous silver tree, which often represents South Africa at international flower shows, is a *Leucodendron*, literally "white tree." When the Dutch East India Company garden was established in the mid-seventeenth century to supply fresh vegetables to passing ships, silver trees were planted as windbreaks. The trees have become rare with the passage of years because of their destruction for firewood, but the Wild Flower Protection Society has ruled that this must cease. Other enemies of this handsome tree are bush fires and a wood-boring beetle that introduces a destructive fungus, which can only be checked by burning the infected wood. The plants of this genus are dioecious — that is, male and female flowers are on different plants. The male flowers are surrounded by a whorl of bright leaves, and female plants bear conelike flowers that are also surrounded by colored leaves. The male tree of *Leucadendron discolor*, more colorful than the female, has yellow leaves and bright red flowers.

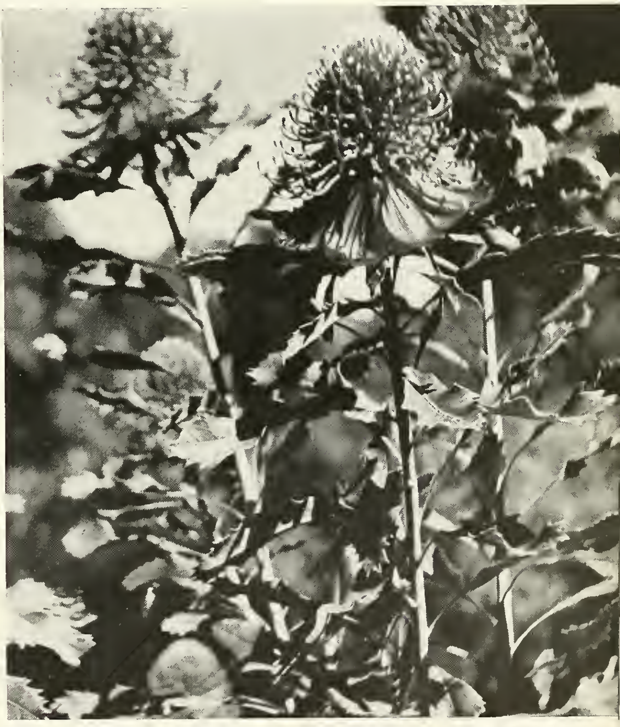
Serrurias are shrubs with needle-like leaves and hairy flowers. *Serruria florida* (the blushing bride) is an unusual species that has hairy flower heads surrounded by showy bracts. The plant itself is straggly and not particularly attractive, but its flowers are among the most beautiful in the entire family.

The inflorescence of *Mimetes* is not as striking as those of the other genera discussed, for instead of having scores of flowers massed together in a tight head, this genus has a few woolly flowers surrounded by inconspicuous, often whitish bracts in the axils of the leaves. The leaves at the tips of the branches are vivid, however, and look rather like a bottle brush.

The rarity of *Orothamnus zeyheri* (the marsh rose) is part of a romantic story of several members of the family — a story of apparent extinction and eleventh hour rescue. One chapter of that story has a happy ending. It is the tale of the blushing bride, the flowers of which are popular in bridal bouquets. In 1914, the year after the estab-



HEADS of *Leucospermum catherinae* are light yellow, and the stigmas, which turn in same direction and give effect of a wheel, are a clear, bright pink.



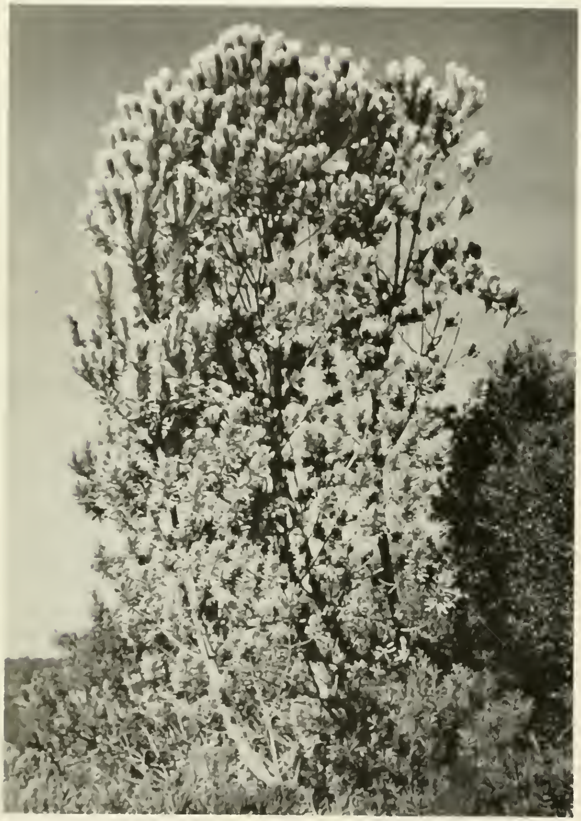
ONE OF FEW "foreigners" in the gardens at Kirstenbosch is crimson Australian protea, *Telopea speciosissima*, known in its native country as the "waratah."

lishment of the National Botanic Gardens at Kirstenbosch, the first director of the Gardens was surprised to spot a few of these flowers at a country flower show. He was delighted to obtain flower heads and germinate the seeds at Kirstenbosch, as the plant was thought to have vanished. Now, forty-nine years later, the National Botanic Gardens supplies seeds from these plants to its members. In 1943, a bush fire destroyed the only wild plants of *Serruria florida* then known to exist, but it has been exciting to botanists to find occasional plants growing in forestry reserves. Meanwhile, a grower has established hundreds of them on his farm in the Stellenbosch area.

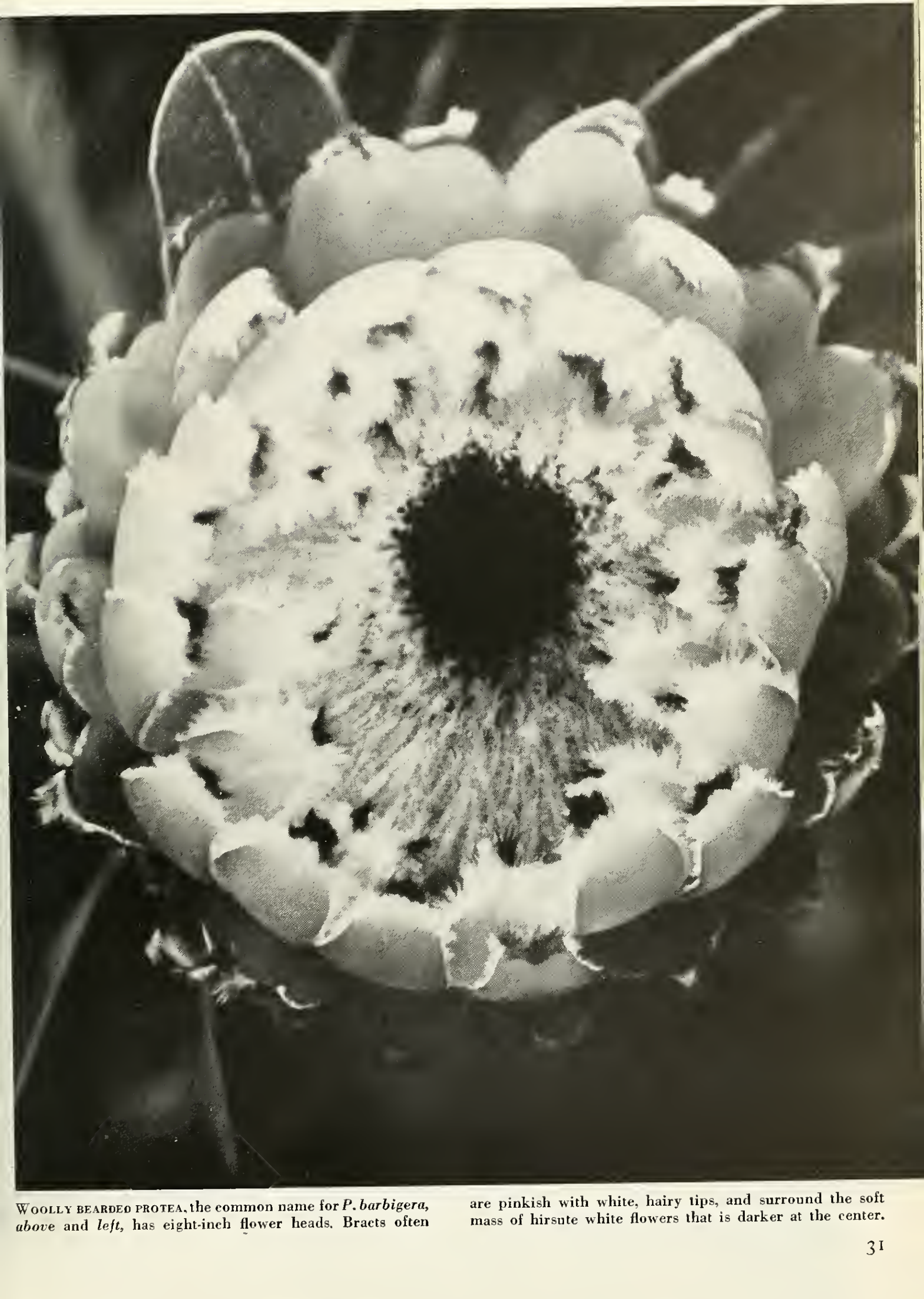
THE marsh rose story may not have so fortunate an ending. This species had been considered extinct for many decades, except by a few people who guarded the secret of its whereabouts. These were mountaineers who knew where to find small, isolated patches of the plant on the high mountain peaks, and brought seed to Kirstenbosch in 1950. *Orothamnus* grows in marshy ground at high altitudes and demands a southern exposure, so is not as adaptable to cultivation as is the blushing bride. When one of these isolated mountain strongholds was visited by our party in 1956, the few plants growing there had been attacked by caterpillars and were a sorry spectacle.

These are but two examples of th dangers besetting the future of pr teas in South Africa. The many-flov ered heads are known to produce a lo percentage of fertile seeds. The pe centage of seed germination is als low, although it is thought by som that unsatisfactory germination o plants being cultivated may be due t unsatisfactory sorting of fertile fror infertile seed. In addition, the seed germinate only in cool soil, and seed lings frequently "damp off." One bot anist has made a comprehensive stud of the plants' growth requirements an has a theory that there is an inhibito on the seeds that can be washed off

THE work of the National Botani Gardens in preserving protea must not be underestimated. Ever sinc the first director of the Garden begge for blushing bride seed at the Fransc Hoek Flower Show in 1914, Kirsten bosch has been actively engaged i growing the proteas. The very situa tion of the Gardens lends itself to thei guardianship, for apart from the fifty acres under cultivation, more than on thousand acres have been establishe on the slopes of Table Mountain as a nature reserve. The present director is working on a book on the taxonomy of the proteas, which, it is hoped, will stimulate even further interest in preserving the plants that are South Africa's floral heritage and its emblem.



SPECIES of silver tree, *Leucadendron argenteum*, grows to twenty-five feet. Name of genus (largest in the family apart from *Protea*) means "white tree."



WOOLLY BEARDED PROTEA, the common name for *P. barbigera, above* and *left,* has eight-inch flower heads. Bracts often are pinkish with white, hairy tips, and surround the soft mass of hirsute white flowers that is darker at the center.

EXAMINATION of the plants that grow on a cutover area engages the interest of these elementary school children.

LIGHT AND SHADE, wet and dry, alive and dead—these are ecological concepts that even the very young can grasp.

Outdoors in the City's Shadow

By Hannah Williams

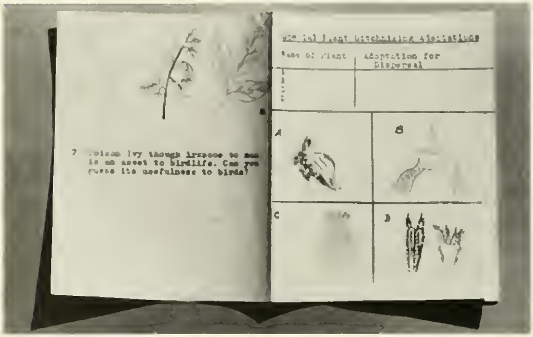
In New York City there are five boroughs in which 7,782,000 people live. At the northernmost extremity lies the Borough of the Bronx. Here 1,425,000 men, women, and children are crowded in private homes and huge housing projects. In other words, the Bronx is part of the architectural complex that is virtually continuous on the Atlantic coast from Washington to Boston. Curiously, until the twentieth century, the Bronx was comparatively inaccessible to the people of Manhattan; it was not until 1904 that the first subway was completed to allow New Yorkers to take to its "salubrious heights." Now each day torrents of commuters flow from the Bronx to Manhattan; each night they return.

On the northwest edge of the Bronx is an area three miles long and half a mile wide, known as Riverdale. It is bounded by the Hudson River, the city of Yonkers, the north extension of famous Broadway, and the Harlem Ship Canal. Even fifteen years ago there were fields in the area where the knowing could find wild strawberries. There were fine oaks, ponds with frogs in them, and little streams that flowed to the Hudson. But this was before the great population explosion. Such terrain could not be expected to survive only fifteen miles from Forty-second Street. In sixteen years Riverdale's population rose from 25,000 to 60,000, and 90,000 is the estimate for 1970. Problems of protecting open land have increased in direct ratio.

Voices have been heard echoing the familiar sentiments of concerned people everywhere. The homeowner says: "Soon there will be nothing here but cement and apartments. Let's move farther out." The teacher says: "A child is an 'expert' on outer space, but how can we teach him the importance of a bug or a glass of water?" The urban developer says: "Why be concerned about zoning? After all, economically speaking, private homes are outdated." Other voices in the cacophony of riveters and drillers say: "While there is still a little undeveloped land within the cities, let us try to hold on to it!"

Perhaps it was in answer to these voices or, perhaps, because in 1959 the buzzsaw threatened a particularly beautiful copper beech tree, that three people in Riverdale met. One was a high school chemistry teacher on leave to study education in natural resources. One was a teacher who had

FIELD TRIPS, led by this naturalist, encouraged teachers in local schools to use the outdoors as a laboratory for developing scientific curiosity.



7 Poison Ivy though irksome to man is an asset to birdlife. Can you guess its usefulness to birds?

[illegible]

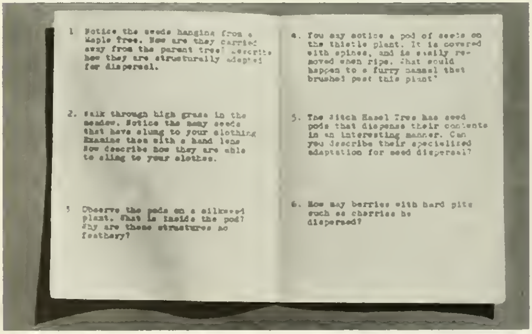
Name of Plant	Adaptation for Dispersal

A

B

C

D



1 Notice the seeds hanging from a Maple Tree. How are they carried away from the parent tree? Describe how they are structurally adapted for dispersal.

2. Walk through high grass in the meadow. Notice the many seeds that have clung to your clothing. Examine them with a hand lens. Now describe how they are able to cling to your clothes.

3 Observe the pods on a milkweed plant. What is inside the pod? Why are these structures so feathery?

4. You may notice a pod of seeds on the thistle plant. It is covered with spines, and is easily removed when ripe. What would happen to a furry mammal that brushed past this plant?

5. The Witch Hazel Tree has seed pods that dispense their contents in an interesting manner. Can you describe their specialized adaptation for seed dispersal?

6. How may berries with hard pits such as cherries be dispersed?

PAMPHLET, one of several prepared by high school students, directed thinking of younger groups to ways certain plants move by "hitchhiking."

been experimenting with local woodlands as a learning experience for young children. The third was a housewife with an interest in city planning. They agreed that most teachers, whether their field was science, social studies, or the humanities, would like to use the world of nature as a teaching tool. They also agreed that action was both important and possible.

RIVERDALE had a cornerstone on which to build an outdoor program that might affect the entire community: The Riverdale Community Planning Association, which for many years had been interested in designing a community to be lived in and not just "developed." It had participated in securing park lands, schools, highway improvements, and sewers for the area. But open space, whether it was a park or a private woodland, was proving harder to protect from dumping and vandalism, so the Association was interested in adding an educational program to its preservation campaign.

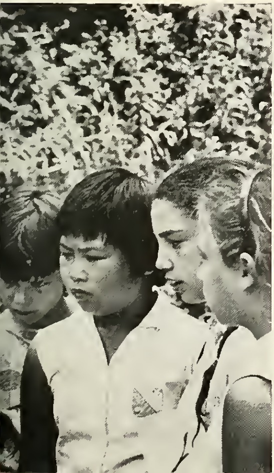
The community was fortunate in having two city parks with generous portions of natural woodland—one is on the Hudson River, and the other is Van Cortlandt Park on the Broadway boundary. In addition, it had three smaller pieces of Park Department-owned woodland near its schools, and several open lots and parcels of woodland in the hands of interested private owners. Eighteen public, private, and parochial schools (ten elementary schools, six high schools, and two colleges), plus several nursery schools, were within the community limits.

A number of teachers on the faculties understood the potential of an outdoor laboratory, but had no idea how to develop it. In addition, a garden club that recognized the key role of teachers in preservation education had offered two-week scholarships to Audubon Camps.

The nucleus of three women talked with members of the Planning Association and came to the conclusion that by pooling the resources of the community three things might be gained. First, if teachers were given help tailored to their available time and to the outdoor possibilities that were within walking distance, they could be encouraged to use outdoor laboratories. Second, if the program was designed to fit their own curriculums, it would not be looked on as an "extra," but instead would be a new aid in developing scientific curiosity. Third, it was hoped that a school program would bring new users to the natural area parks, and that the presence of students would focus attention on protection and maintenance.

So the three women approached the Planning Association with their idea —the introduction of a short course for teachers in the use of open lots and parks near their schools. The Association contributed $250, and the program was launched.

Naturally, the first problem was that of staff—particularly needed was a naturalist with a gift for teaching. They found him in a conservationist-naturalist who had recently moved to Riverdale, and under his leadership a slightly enlarged group of teachers



Gifted high school students, at left and above, worked out programs for younger children to demonstrate the value of looking, feeling, smelling.

EROSION and water control became a real problem to young people, *above*, when basic principles were studied as they actually operate in nature.

AY CAMPERS pursued subjects that articularly interested them. Boy, *lower left,* made soil analysis notes, another, *below,* collected insects.

from various schools pooled their ideas for a ten-day course. The only paid member of that first staff was a leader for field sessions—a trained teacher of biology. A second fieldworker was the co-ordinator of science projects for the Bronx High School of Science. A chemistry teacher, who was on leave from a local private school to do research for The Conservation Foundation, completed the staff.

TWENTY-NINE teachers enrolled that first year for the field trips, educational films, and lectures that comprised the course. They called it a success, but their requests indicated that some organization was needed to supply more services, to develop one park as a model outdoor laboratory, and to plan for the day when there might be a center in which to house classes, exhibits, and a library of books and visual aids.

Now the founding group knew it needed assistance, and it appealed to a number of organizations. To their delight, help poured in. The National Audubon Society had a wealth of project suggestions and simple instructions on how to carry them out. The Conservation Foundation, although devoted mainly to specific research programs, made available films, visual aids, and publications. Many other sources contributed valuable advice, but in no case was a proposed plan exactly applicable to the city environment of Riverdale. Thus, the planners were forced to examine resources in the community it hoped to serve.

The group found that cities have one resource par excellence, a reservoir of trained minds. Instructors and naturalists were located and these men and women were paid per diem as generously as could be managed. Meanwhile, it had become all too apparent that an administrator was essential. Here the group turned to an interested housewife who could donate fifteen hours a week and who was supplied with a telephone and secretarial services. Her duty was to coordinate the roles played by the city's Departments of Parks and Sanitation, the Board of Education, private and public schools, community organizations, and educational consultants. She was also in charge of publicity for what was now to be known formally as the Riverdale Outdoor Laboratories. (After two years of volunteer work

ANIMALS were sent by the pupils of a private school to kindergartners, first-, and second-graders in public schools. Some 700 children profited.

with her office expenses paid, she was also given a part-time salary.)

The planning for the balance of the school year was done by a steering committee of teachers in co-operation with paid and volunteer staff members. During the last week in March and the first week of April in the second year, 514 children from seven schools made class visits to the park on the Hudson River. Instructors geared the walks to the curriculum of the public and private schools from which the groups came. As a result, some of the children studied Indian foods; some concentrated on soil erosion; some examined plant growth that appears on a cutover area.

These two programs—the teachers' course and the field trips for school groups—remained the backbone of the Laboratories' service to schools for the following two years. However, other services were offered. A one-day session to demonstrate nature activities that were possible within the con-

TURTLE becomes subject for serious consideration by these youngsters, who here are given a chance to see, touch, and—most vital—to question.

fines of a city park was organized for counselors from eleven day camps run by neighborhood houses and settlements. Forty counselors attended, and the cost was shared by the Community Council of Greater New York and Fieldston School, one of the private schools in Riverdale. The local garden club contributed money for a survey of the Hudson River park as a step in developing it as a laboratory and sanctuary. Walks in the park, with a naturalist in charge, were made available to the general public.

SLOWLY, slowly, the program was beginning to gain impetus. Some of the progress might appear dull in the spelling out. But it was not dull to those who had initially envisioned its scope and who now saw it taking shape. By 1961 the Riverdale Outdoor Laboratories had begun to spread in many directions—but with caution.

In the spring of that year, group conferences were held in eleven participating public and private schools to plan field trips that would help coordinate school curriculums and interests with projects in which enthusiasm could be sustained throughout the spring. For instance, for a whole term one teacher kept a class interested in water by means of projects that dramatized watersheds and how their use was controlled politically as well as physically. These students had a field trip planned specially for them. They measured the rate of flow in a stream; they recorded observations of silting; they built check dams; they tested water for degrees of pollution and kept field sheets to record data on which to base conclusions.

In the meantime, the program was beginning to pay dividends in several different directions. For instance, three nursery school teachers had for a number of years used a small patch of woodland near their school for occasional excursions. It was not until two of the teachers had taken the training course that they began to realize that small children can absorb very advanced ecological concepts.

Two private elementary schools and one public school felt the influence of the course in almost all their grades. One added a naturalist with conservation training to the permanent science faculty, and the two other schools developed projects and pamphlet guides to be shared with the rest of the participating schools. One was a study of water, the other a year-long record of temperature and growth changes on a single plot of land.

Most important has been the development of a concept of the interrelationship of all living things, and a strong endorsement—by both teachers and students—of the "let's-find-out" approach, which is in sharp contrast to the "I'll-tell-you" attitude. Also encouraging was the general acceptance the teachers' course was gaining, and the solid relationship that had been built with the participating schools, which had contributed space for shelter, a lecture, a teachers' course, a meeting, or an exhibit. The Board of Education was willing to consider the teachers' course for in-service credit, and the program, revised to fulfill requirements, was accredited in February, 1963.

By the spring of 1962, the staff had grown to nine, including members recruited from the Bronx High School of Science, The American Museum of Natural History, the New York public schools, and Montclair Teachers College. And by then the program ranged from nursery school to college and involved children, teachers, and parents.

Some programs were planned for larger groups. An animal visiting program for kindergarten, first, and second grades was offered by one private school as a service to two public schools. Almost seven hundred youngsters saw the traveling rabbit, guinea pigs, salamander, and frogs. A lecture on the geological formations of the area was arranged for the fifth and sixth grades in one public school. Classes took field trips with staff members—1,120 children were involved in this project. Sunday walks were arranged for families to discuss local history, flora, and bird migrations.

Of course, it must be apparent that none of this expanding operation would have been possible unless funds had also expanded. During the second year of the Laboratories, The Riverdale Community Planning Association added a zero to their original gift of $250 and contributed legal advice. The third year, their contribution was matched by a foundation. An additional $1,500 was received from a second foundation to finance summer day camp sessions for high school students—the most ambitious program of all.

The camp was set up for a six-week period, to accommodate ten gifted biology students about fourteen years old. It had a triple objective: to allow the children to pursue a subject of interest to themselves and thereby to learn something about scientific method; to help them experiment in ways to make outdoor learning of interest to younger children; and to make the Hudson River park more useful as a biology teaching station. Students were selected for their aptitude and interest, not because they needed a place to spend the summer.

One boy made a study of soil chemistry; a group of girls concentrated on plants of economic importance; many became interested in insects; one group banded and recorded animal populations. They labeled trees, pressed and mounted plants, made maps, and improved trails. One of their most rewarding activities was in making project sheets. These were thought out and illustrated to supply younger children with new ways of looking at the park and what it had to offer. The sheets were twice-folded pieces of 8 by 10 paper. The high school students drew pictures on the outside, and inside posed a series of questions they felt would stimulate observation and interest. The subject matter was broad. One sheet was devoted to reptiles and amphibians, two to wildflower observation, one to fresh-water ecology, two to what can be smelled or heard in the woods. Feeding habits of birds were covered, as were erosion, the geology of the area, and animal and plant interrelationships. Typical questions are contained in the project sheet on "hitchhiking plants," *shown on p. 34.* (The cost for that summer's program was $200 a student—and it was very well worth the price in over-all results.)

WHAT has been accomplished by all the work of the last few years? There are many ways of looking at it. Some people would measure it on the basis of the dollars spent—this has increased from $250 to $6,500 a year. A good investment? Some people would judge on the basis of the land acquired and the parks protected. Worthwhile? Some would estimate success in relation to the number of schools and children served—and that tally stands at eleven of the former and 1,785 of the latter—not too bad a record for the third year of operation.

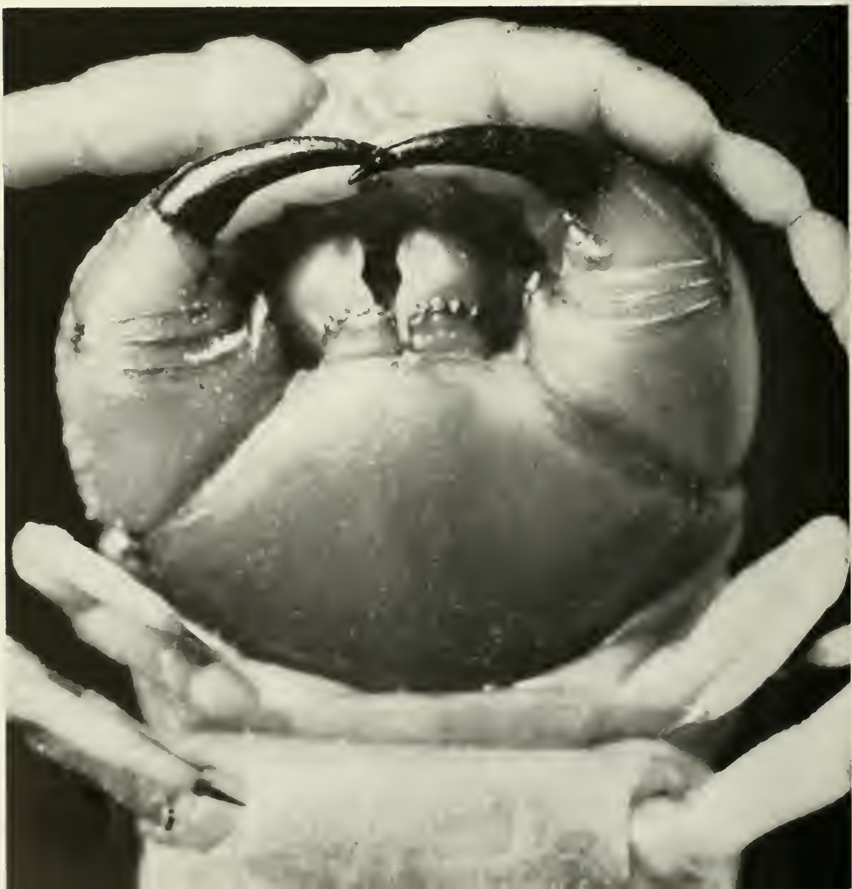
Perhaps the clue to the effectiveness of the Riverdale Outdoor Laboratories—and one that could well be a clue for any other community that is interested in such a program—lies in individuals. It may be one teacher who finds a new approach to field work and puts it in a form other classes can use. It may be another teacher who will not relinquish the search for a way to encourage even the youngest child in the delight of discovery. It might be a single child whose enthusiasm communicates itself to dozens of his classmates. In any case, it is not insignificant that an alert school student or his parent can, with expert guidance, begin to see that one tiny spot of ground can be translated into a park that can be a world of beauty, excitement, speculation, and study.

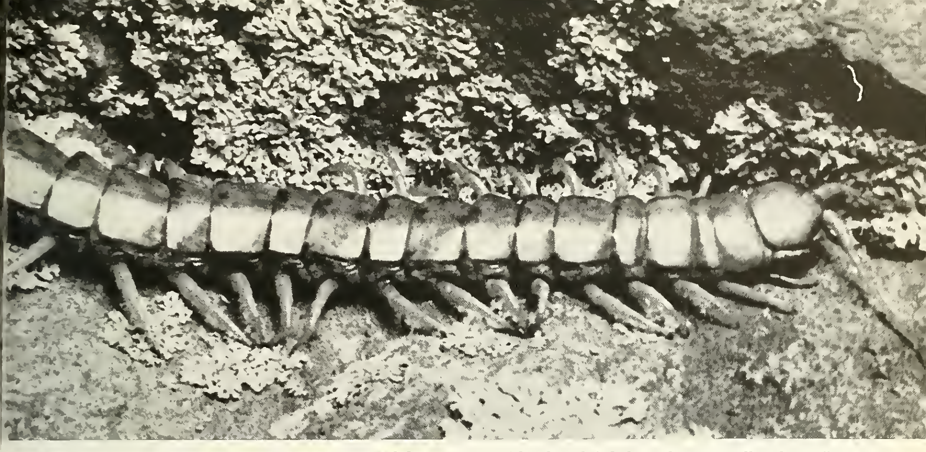
EVEN A SMALL PATCH of woodland in a city setting can offer excitement.

Nature lies as surely in this small space as in hundreds of square miles.

SEED DISPERSAL, not the annoyance of sticktights, occupies this youngster.

Centipede's Spiral is Live Shelter





Common centipede of Mediterranean countries and Middle East, *Scolopendra cingulata* is highly venomous. A ventral view of head, at left below, shows maxillipeds, or "poison claws," which pierce victim and inject poison from glands.

Female chilopod protects eggs by coiling body around them

By Fritz Schremmer

There are four orders in the class Chilopoda, and they are represented throughout the world. Some are one inch long, others two or seven inches in length, and one tropical species attains slightly more than ten inches. This group of animals is better known as centipedes.

Not all of them have a hundred legs. Some centipedes have as few as thirty; others may have over 350. But no matter what their locomotive ability, they are constructed essentially the same. The body is divided into varying numbers of sections, on each of which is a pair of legs. The head carries a pair of segmented antennae and three pairs of mouthparts. Behind the head is the first body segment, and on this are appendages known as maxillipeds. These are the "poison claws," which have venom glands in their terminal segments. If enemies are to be attacked or prey to be caught, these claws move in pincer-like fashion and with lightning speed. The tips penetrate the body and at the same time discharge the poison. Apparently, the venom of some species is considerably more virulent than that of others. For instance, that of *Scolopendra cingulata,* the species shown on these pages, can cause real discomfort and pain to humans.

S. cingulata, like most centipedes, is nocturnal and lives in warm, dark places under logs, rocks, and rotting bark. It is straw-yellow or olive-green in color and is widely distributed in the Mediterranean regions of Europe, North Africa, and the Middle East. Its size varies in the different localities.

But perhaps the most interesting aspect of this carnivorous animal is the way in which the female protects its progeny—the eggs—by covering them with its own body. The process is much more careful and elaborate than, for instance, that of a hen, which simply sits placidly on the nest. The centipede winds its ribbon-like body around the cluster of eggs in about two and one-half turns, with the legs pointing in. The spiral thus formed is so tight that none of the twenty to twenty-four eggs can be seen from the outside, and none touches the ground. In this way the eggs are completely protected from the attacks of predatory insect larvae and other small animals that hunt through cracks in the ground or dig through soil for food.

The main egg-laying period is from the end of May to the middle of July. Before spawning, the centipede digs itself several centimeters deep into the soil, commonly under a flat stone. This burrowing is done with the head and mouthparts, not by contracting and expanding segments like an earthworm. Then it hollows a small chamber in which it lays its eggs and guards them until the young have hatched and are several days old. In this chamber there are other dangers from which the eggs must be protected, specifically the suffocating growth of molds and, perhaps, attacks by bacteria. The centipede lies tightly rolled in its chamber for two to four weeks, but it is not entirely immobile. Now and then it loosens its body coils and picks an egg from the cluster. Then, holding it with the maxillipeds and the first pair of legs behind the mouthparts, it gently licks the surface, removing all fungal material. This action probably also coats the surface of the eggs with a layer of saliva that might serve the double purpose of a cleanser and of a fungicide and bactericide. Certainly, it is known that if the eggs are separated from the mother they become infected with fungi in a few days, and licking may keep spores from forming.

If the animal is disturbed and unrolls somewhat, revealing the egg cluster, one can see how carefully the latter is held together by the legs, which surround it like a fence or a screen. If the body has unwound too much and an egg escapes, it will be gathered in. In this process the egg is held by the maxillipeds. Bending the head inward, the animal passes the egg onto the anterior pairs of legs until it is again tucked in the cluster.

FEMALE GUARDS EGGS during the two to four weeks before they hatch by coiling body around them. If disturbed, she loosens coil temporarily, as shown in the photo sequence counterclockwise from upper left. Centipede occasionally opens coil to lick eggs, thus removing any fungal growths.

Palmate Stone

Frog

Jaguar Metate

Corn Goddess

Blue Pottery Vase–Dragon Vase

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Palmate Stone

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Frog

The place of origin of this nicely styled frog sculpture is unrecorded, but it would appear to have come from the highland regions of Mexico, probably from Oaxaca. Most likely it is of the Post-classic Period (900-1500 A.D.) for it is comparable to the realistic animal sculptures that are well known in Aztec art. 10½ inches high . . . $45.00—shipping charges collect

Jaguar Metate

This exceptionally fine example of a jaguar metate or grinding stone comes from near the town of Boruca in southern Costa Rica. It is probable that the original of this piece was made at least several hundred years before the Spanish Conquest in the 16th century. 35 inches long by 9 inches high . . . $150.00—shipping charges collect

Corn Goddess

This is Chicomecoatl (seven snake), the corn goddess, depicted as a young woman. Seemingly she is meant to invoke the spirit of the young corn—of fertility and of promise. The original Aztec sculpture dates from 1350-1520 A.D. 20½ inches high . . . $125.00—shipping charges collect

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This is a reproduction of a rare jade piece of the Han Dynasty (202 B.C.-220 A.D.). The carved design is a highly stylized representation of a dragon. Reproduction in Alvastone stands 6½ inches high . . . $16.25 ppd.

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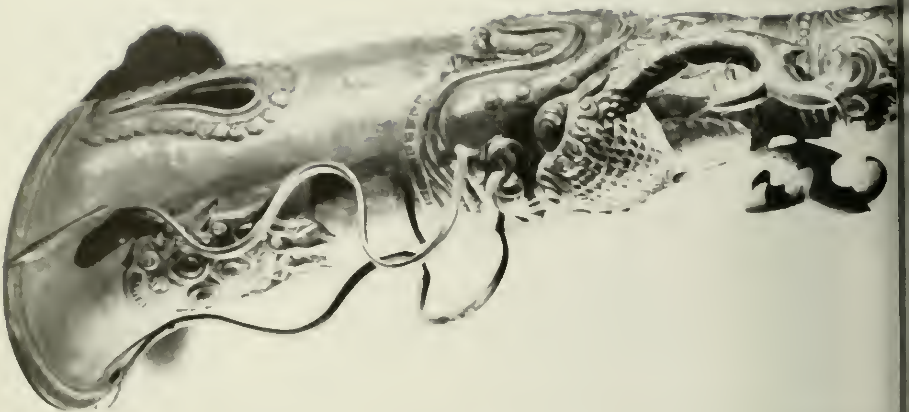
Music, Men and Gods

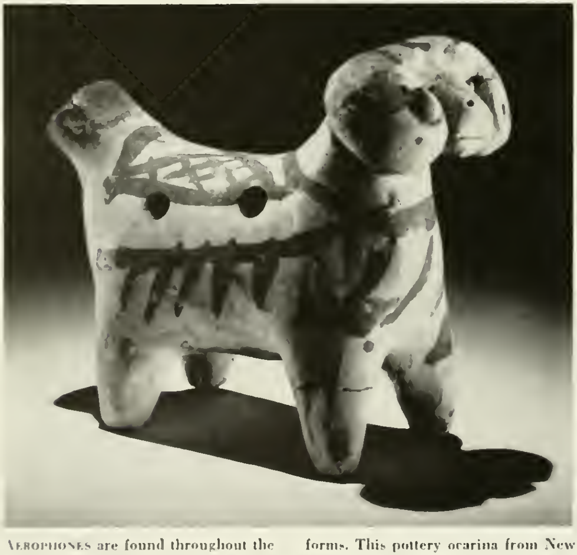
By Colin M. Turnbull

Photographs by Lee Boltin



ORNATE Tibetan wind instrument, shaped like a human thigh bone, would not appear a close relative of the masklike flute on the preceding page. But both belong to the same family of musical instruments, aerophones, which produce

MAN'S URGE TO MAKE MUSIC STEMMED FROM PRACTICAL



AEROPHONES are found throughout the world in a wide variety of indigenous forms. This pottery ocarina from New Mexico was molded in shape of a ram.

SINCE THE DAWN of humanity, man has made music. Whatever his condition, his ingenuity enabled him to make an amazing variety of musical instruments with the simplest tools and materials. Over the ages some of these have grown in complexity, others have remained much as they began—they were already perfect in their own individual ways and functions.

But it took more than mere ingenuity to create the wealth of music that exists with persistence even in the most primitive societies today: the urge to make music had far deeper roots than the desire to while away the leisure hours. The world of sound was of vital concern to everyone, for it was directly connected not only with everyday life but also with the greatest mystery of all—the life beyond. Just as music was used as a means of communication between man and man, so was it used for communication between man and gods. Even in our own society traces of these early beginnings remain: the carillon of church bells calling the faithful to worship, the hymn-singing of the congregation, the use of hand bells during

ound from the motion of air blown through a hollowed out assage. The mask-flute was made by American Indians of the Pacific Northwest, while the elongate horn is a cousin to actual human bone horns played in Tibetan monasteries.

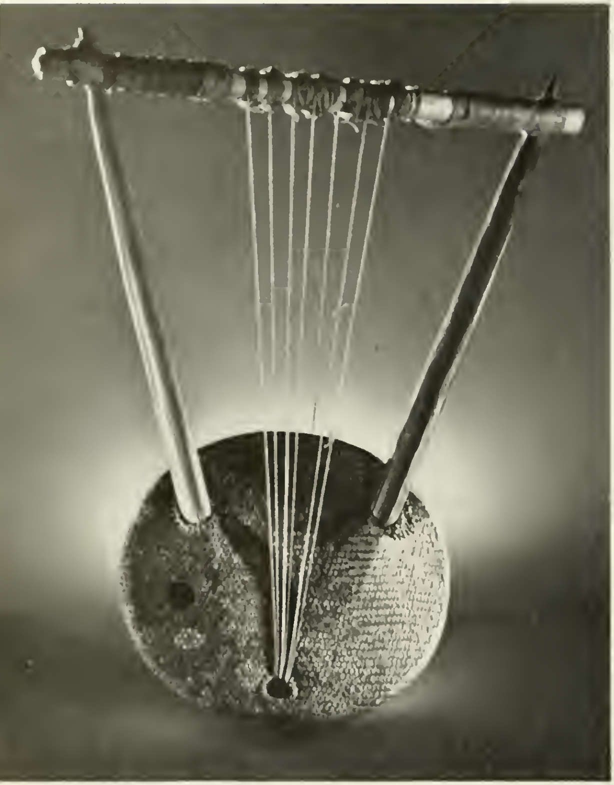
NEEDS TO COMMUNICATE WITH OTHER MEN AND GODS

e Mass, the intonation of prayers, e use of the organ during a service.

Still other refinements developed. n our society, as everywhere else in e world. there are superstitions bout whistling and beliefs in the agical power of wind instruments, uch as the trumpets that brought own the walls of Jericho. Perhaps it s the close and obvious association of reath with life that makes wind intruments take on magical power. For hatever the reason. it is a fact that ome of the very earliest instruments nown are the bone whistles used in agical rites by American Indians, nd the ceremonial pottery flutes of exico. In Tibet, the trumpet is indisensable to the effective performance f religious ritual. just as is the conch n India. In Africa, whistles and rumpets are used to attract protective pirits. Everywhere there is belief in he magic power of the breath of life.

But music is not only used for comunicating with the world beyond; it lso has its very practical uses in the orld of the living. Drums and gongs re used for sending messages from ne village to the next; trumpets are

LIGHT, multiple whistle from Orient, shown here at about twice actual size, was attached to the tail feathers of pigeons and sounded when birds flew.



EAST AFRICAN lyre, *above*, belongs to a second family of musical instruments called chordophones, in which sounds come from vibrating the taut strings.

STRINGS of the African harp, *above*, are plucked, as with the majority of

used for signaling the direction of the hunt. Generally, it is the simplest instruments that have the most practical functions; when we come to the more complex instruments we find that their ritual association diminishes, as does their more obvious utilitarian value. String instruments, or chordophones, were developed very early in the Orient and achieved a remarkable degree of complexity with little evident function other than recreation.

However, if we consider more carefully the nature of a string instrument we can see that there *is* a connection, once again, with the world beyond. It is difficult to say which came first; more likely the two grew together. In any case, one finds in the Orient not only a high development of string instruments but also a high level of discrimination between minute variations in pitch. Obviously, the finger sliding up and down a string is admirably suited to rendering the smallest differences between one note and the next. The concern of the Oriental with these microtones was not merely aesthetic; it was essentially practical, connected with a system of modes, or scales.

UNDER this system there are certain modes that are applicable only to certain times of the day or year and to certain situations. In India, for instance, there are scales applicable only to the rainy season, and there is no doubt that originally it was believed that the correct performance of this mode would have a definite effect on the rainfall. Today many Indians are not apt to believe in quite such pragmatic effects, but accept that definite modes produce definite emotions that correspond to certain situations; the scales are used to suit these emotions as well as to induce them. The very complexity of the system demands the utmost discrimination of pitch, and strings are better adapted to achieve this than are less sophisticated instruments.

When the same instruments are transplanted to other soil, however, and when established musical practices already exist, they often lose their old function. From the Orient string

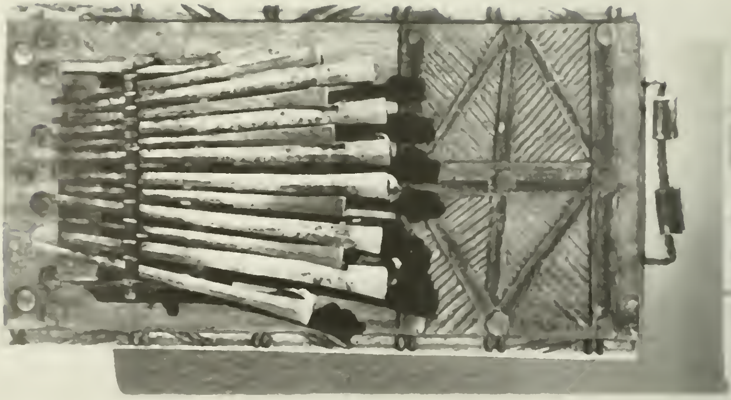
hordophones: bowed instruments first eveloped in the Orient. The harp and lyre probably were originated in Africa, deriving from the hunter's short bow.

struments came to Africa, and al- ough the idea of bowing a string ever became widespread on that con- nent, there exist today a vast number nd variety of string instruments in frica. Some of them, such as the lyre nd the harp, even seem to have had eir origin there. In no case did their usic have any ritual or magical signi- cance. Rather, it took on a totally ew function, one of the most impor- nt functions of music, not only in rimitive society but in medieval urope or wherever there was illiter- cy: it assumed an educational role.

Wandering minstrels roamed the ountry with their lyre or harp, sing- g ballads much as did the Western oubadours. In the smallest villages as in the most royal courts in Africa one still finds professional musicians relating news of current events, telling morality tales, and recounting the past history of the tribe, with all its glories, victories, and defeats. In this way an illiterate population is kept alive and united in a common knowledge of a common heritage.

String instruments are also used for hours of relaxation. A man may sit down and sing to himself, accompanying the song by plucking on a simple lute made from a stick, a gourd, and a length of twisted vine that serves as a string. He does not have to be a professional, earning his living by song. He may sing to his children just as the minstrel sings to the court.

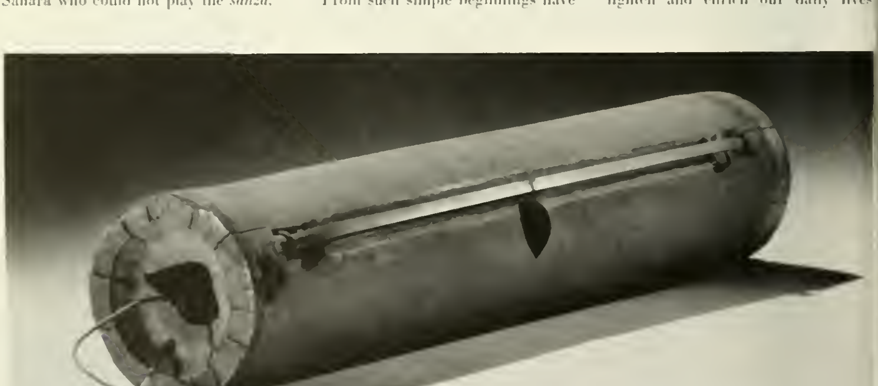
NARROW-WAISTED sarangi from India, *above*, allows for free passage of bow.



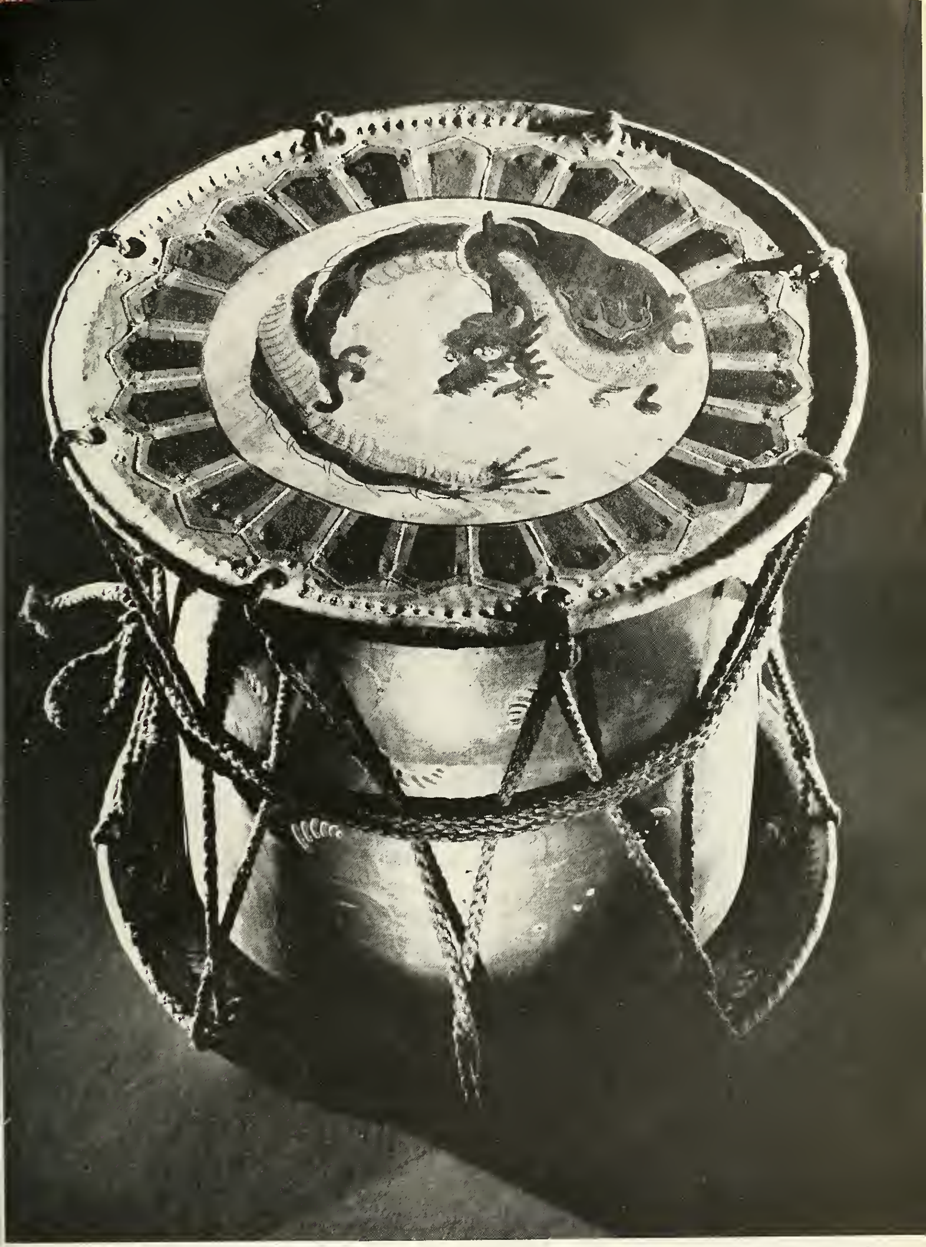
Third family of self-sounding instruments, the ideophones, includes a wide range of rattles, buzzers, cymbals, bells, gongs, and keyed instruments, such as the African han piano, or *sanza, above*, a distant relative of the xylophone

Music, then, has also had its lighter moments, even in the distant past. It accompanied dancing that was by no means always ritual; it told tales of love as well as of war. It has always been one of the greatest recreations open to man, and it is only in our own overfull, overworked world that we cannot, each one of us, make our own music. In Africa, for instance, it would be rare to find a villager south of the Sahara who could not play the *sanza*, or "hand piano." The bamboo or metal keys, which are plucked with the thumbs, can be moved backward and forward to obtain different tunings. Equally simple and effective is the zither, originally a single tube of bamboo with one strip of the outer skin raised over two bridges. This only gave a single note, but more were obtained by raising strips or by lashing several "monochords" together.

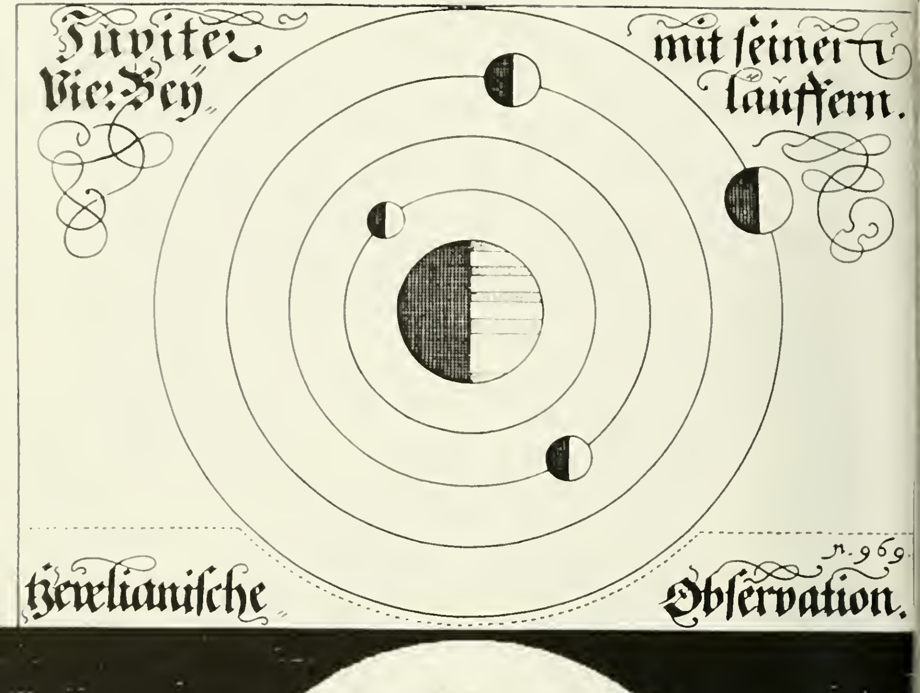
From such simple beginnings have come some of the loveliest musica instruments and some of the greates music. Whether its purpose was onl for its use in festivals, as with th Chinese flower drum, or whether i was designed to establish an intimat communion between man and hi gods, music has always been the common property of mankind throughou the world and has served, not only t fill us with pleasure, but also to enlighten and enrich our daily lives



Impossible to classify simply, this instrument is an ancient archetype of the zither family. Originating in Indonesia, it is called a monochord because of its one string (although sometimes there are more), which is raised above bamboo.



Last of four conventional families is membranophone. In this forerunner of the modern drum, sound is created by vibration of the skins. Often the skin covers only one end, or, as in this Chinese drum, it may stretch over both.


Jupiter
Vier Bey
mit ſeinen
lauffern.
Hevelianiſche
n. 969.
Obſervation.

SEVENTEENTH-CENTURY DRAWING shows Jupiter and Galilean satellites, top. The relative distances and the sizes are not correct. Hevelius' depiction of Jupiter is below. The surface marks may have been optical aberrations in his telescope.

SKY REPORTER

Jupiter, largest of the planets, has twelve known satellites

By Simone Daro Gossner

Galileo Galilei was a good physicist and astronomer, but when he reported sighting *four* satellites of Jupier through his new telescope, the German astronomer Kepler was skeptical, at least until he verified Galileo's observations himself. Contemporary Aristotelian philosophers reasoned that if Aristotle had not mentioned Jupiter's atellites, it had none. They would not look through telecopes lest they might have to change their minds.

If any planet may be said to hold a privileged rank in he solar system, it is Jupiter that deserves the distinction. Bigger (eleven times the earth's diameter) and more massive (317 times the earth's mass) than any other planet, Jupiter also has the largest family of satellites, with twelve known at present. The gravitational attraction of this enormous hulk, which is more than twice the combined mass of the other eight planets, plays a dominant role in shaping the orbits of all the bodies in the solar system.

Traveling around the sun once every twelve years, at an average distance of 483 million miles, Jupiter never comes any closer to earth than approximately 380 million miles. At such a distance, it is impossible to detect the finer deails of its surface with present observing equipment. In he telescope, it appears as a bright disk, blurred and dark around the edges, and appreciably flattened at the poles. The flattening is caused by its rapid rotation: one day on Jupiter lasts slightly less than ten hours.

The disk is slashed by alternating dark and light bands hat lie parallel to its equator. Several thousand miles wide n places, they have ill-defined edges and are not permanent surface features. Because Jupiter is almost entirely gaseous, it does not rotate as a solid body. Like the sun, it rotates faster around the equator than near the poles. The bands are believed to arise from shearing effects between contiguous regions with slightly different rotation speeds.

Most puzzling of the surface features is a semipermanent one, the Great Red Spot, which has persisted for more than a century. Located at intermediate latitudes in Jupiter's southern hemisphere, it seems to behave as a solid body floating in the planet's atmosphere. Its oval shape has varied considerably in size over the years, from a mere notch in the south tropical band to a huge ellipse 30,000 miles long and 7,000 miles wide. Its nature is unknown, but a recent theory suggests that it may be the top of an enormous column of gas that hovers above a mountain range deep inside Jupiter's visible disk.

This theory presupposes that Jupiter does have a solid surface underneath its thick atmosphere, which has not been fully established. Spectroscopic studies indicate that the outer layers of the planet contain methane and ammonia. Much of the latter is probably in a frozen state, since the temperature of the visible surface is found to be 230°F. below zero. The bands, for example, probably contain clouds of frozen ammonia crystals. It is believed, however, that methane and ammonia are only minor constituents, with a prevalence of hydrogen and helium. According to recent calculations, hydrogen may account for 80 per cent of Jupiter's mass. Under the huge gravitational pressure of Jupiter's total mass, this hydrogen must be compressed into increasingly dense layers as the center of the planet is approached. No longer a gas in the ordinary sense of the term, it must be in a liquid state at intermediate levels and in a metallic phase near the center. It is not known whether the transition from one state to the next is gradual or whether there are sharp boundaries. Current views favor the existence of a solid hydrogen surface deep in the interior.

In addition to being the largest and most massive planet of the solar system, Jupiter is also the strongest emitter of radio waves. First detected in 1955, they revealed that the planet is surrounded by a Van Allen belt similar to the earth's but considerably more intense. It consists of electrically charged particles trapped in a very strong magnetic field. Jupiter also emits radio waves in short bursts of great intensity. Although they occur at intervals comparable to the duration of the planet's day, these bursts cannot be identified with any visible feature. They may be caused by magnetic storms in Jupiter's ionosphere.

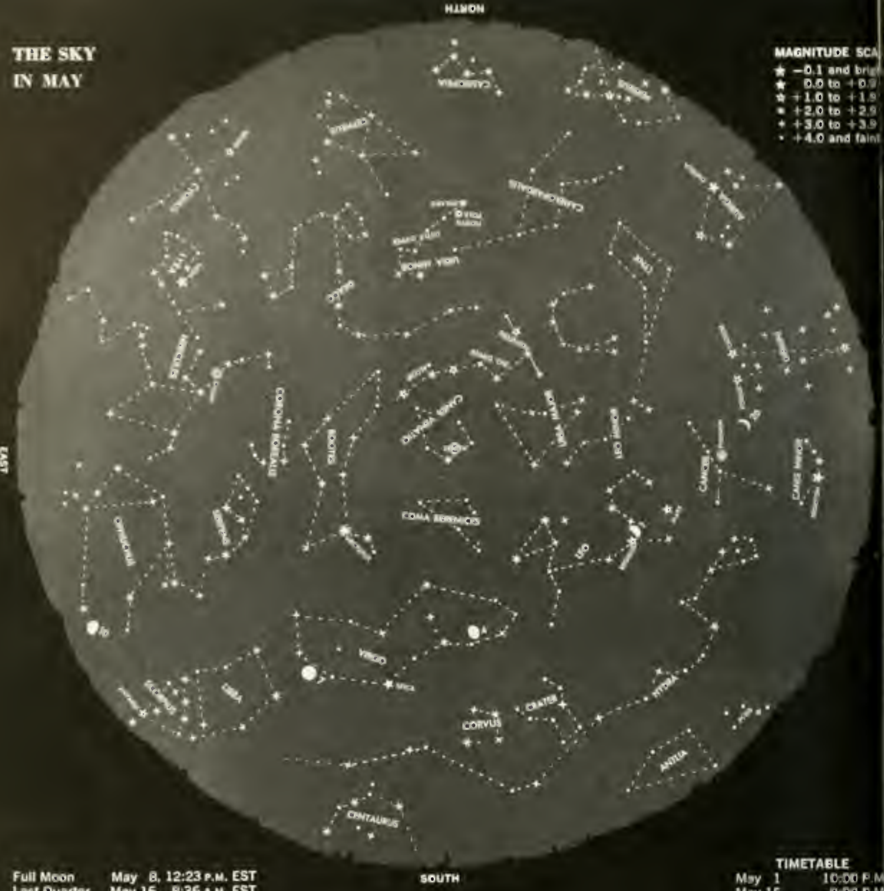
Until the end of the nineteenth century, only the four Galilean satellites were known. All others are much fainter and their discovery required much more powerful telescopes. A fifth was spotted in 1892, followed in quick succession by three more in 1904, 1905, and 1908. The remaining four were all found by S. B. Nicholson at the Mt. Wilson and Palomar Observatories—one in 1914, two in 1938, and one in 1951.

The four bright satellites have diameters ranging from 1,800 to 3,100 miles. Their well-defined surface markings facilitate the determination of their rotation periods. It has been found that, like the moon, they continually keep the same face turned toward their parent planet. Their estimated densities and the manner in which they reflect light suggest that their interiors may consist of rocks and some traces of metals, and that their surfaces are probably coated with snow or heavy layers of ice.

The other satellites are so small, with diameters not exceeding a hundred miles, that nothing is known of their physical nature. However, omitting the innermost one, their distances from Jupiter and their motions around it exhibit unusual characteristics. Three lie at distances ranging from 7.1 to 7.3 million miles from the planet, with orbital periods of 251 to 260 days. The other four have distances of 13.0 to 14.7 million miles and periods of 625 to 758 days. Furthermore, all four satellites in this last group travel in retrograde orbits, that is, in a direction opposite to the usual mode of travel in the solar system. The most plausible theory offered thus far to explain this notable behavior is that at one time in its remote past Jupiter captured two fairly large satellites. In the process, both shattered, creating the two groups we now observe.

On these pages Mrs. Gossner presents the fifth in her 1963 series—a co-ordinated review of the solar system.

THE SKY IN MAY


NORTH
MAGNITUDE SCA
★ −0.1 and brig
★ 0.0 to +0.9
✩ +1.0 to +1.9
• +2.0 to +2.9
• +3.0 to +3.9
· +4.0 and faint
CASSIOPEIA
CAMELOPARDALIS
URSA MINOR
URSA MAJOR
DRACO
HERCULES
CORONA BOREALIS
BOOTES
CANES VENATICI
COMA BERENICES
LEO
CANCER
CANIS MINOR
VIRGO
SPICA
LIBRA
SCORPIUS
HYDRA
CRATER
CORVUS
ANTLIA
CENTAURUS
EAST
SOUTH

Full Moon	May 8, 12:23 P.M. EST
Last Quarter	May 16, 8:36 A.M. EST
New Moon	May 22, 11:00 P.M. EST
First Quarter	May 29, 11:55 P.M. EST

TIMETABLE

May 1	10:00 P.M
May 15	9:00 P.M
May 31	8:00 P.M

(Local Standard Time)

For the visual observer:

Mercury will be suitably placed for observation only for the first few days of May. During that period, the planet will be in the evening sky, setting about one and a quarter hours after the sun. At inferior conjunction on May 17, it will enter the morning sky on that date, but will remain too close to the sun to be seen for the rest of the month. Even on May 31, it will rise only forty-five minutes before the sun.

Venus (—3.3 magnitude) will rise in the morning sky approximately an hour before the sun throughout the month, and it will be found low in the east at dawn.

Mars, in Leo (+1.0 magnitude), will be overhead at dusk on May 1. It will set in the northwest at 2.00 A.M., local standard time, May 1; 1:00 A.M. May 15; and at midnight May 31.

Jupiter, in Pisces (—1.7 magnitude), will be found in the eastern sky at dawn, rising one hour before the sun on May 1, one hour and forty-five minutes before on May 15, and two hours and thirty minutes before on May 31.

Saturn, in Capricornus (+1.0 magnitude), will rise at 2:00 A.M., local standard time, on May 1, 12:45 A.M. on May 15, and 11:30 P.M. on May 31, and will remain visible for the rest of the night. In early May, the planet will reach the south eastern sky by dawn. By the end of the month, Saturn will b found almost due south at sunrise.

Readers are cautioned that all times quoted on this pag are given in standard time. In localities where Daylight Savin Time is in use, one hour must be added to the printed times When Eastern Standard Time is specified, as for the phases of the moon, the instant at which the phenomenon occurs i the same everywhere; therefore the user must convert th printed time to that of his own time zone (add one hour fo EDT, no change for CDT, subtract one hour for CST and MDT subtract two hours for MST and PDT, subtract three hours for PST). Strictly speaking, the local times of rising and settin of the planets and those pertaining to the sky map are correc only for the central meridian of each time zone. Inevitabl discrepancies, ranging from a few minutes to half an hour must be expected in places with longitude that differs fron that of the central meridian. To obviate this difficulty, times o rising or setting of planets are stated relative to sunrise o sunset whenever practicable, and the time interval quoted i independent of the longitude of the observer's location.

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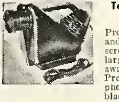

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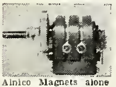

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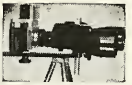

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Naturalists' Notebook

Extensive thickets of cypress trees, *left*, cover much of the Okefenokee Swamp's vast expanse. Roughly one-fifth of the morass is an open marsh.

Sandhill crane is one of a multitude of water birds that live in swamp. Other denizens include otters, bears, raccoons, and white-tailed deer.

MASSIVE MARSH

Varied wildlife roams Okefenokee Swamp

Spanish conquistadors in the New World discovered, in 1539, a "great morass" bordered by forests of huge, tall trees. They found the underbrush there was impenetrable. The explorers were traveling with DeSoto, and the area they had found is known today as the Okefenokee Swamp.

The swamp occupies about seven hundred square miles, almost entirely on the Georgia side of the Georgia-Florida boundary. Four-fifths of the swamp is devoted to the 331,000-acre Okefenokee National Wildlife Refuge, which is administered by the Bureau of Sport Fisheries and Wildlife.

Among the swamp dwellers a visitor may see during a tour of the refuge are alligators, raccoons, bears, otters, and a host of water birds. And islands in the swamp are havens for white-tailed deer and wild turkeys.

Much of the swamp floor is overlaid with a thick peat deposit that is quite unstable in some areas. In fact, the peat is twenty feet thick in spots. One spectacular result is that large cypresses rooted in the upper level of the peat bed can sometimes be made to tremble by stamping one's feet on the surface of the layer of peat. The Indians who inhabited areas near the swamp hundreds of years ago were aware of this phenomenon. Their name for the morass—Ouaquaphenogau—meant "land of the trembling earth."

Alligators abound along the swamp's twisting watercourses. The principal outlet for Okefenokee's brown-stained waters is through the Suwannee River.

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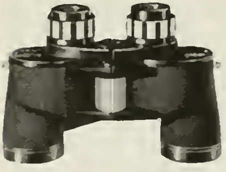

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About the Authors

Dr. Meredith L. Jones, author of "Complexities in the Substrate," is Assistant Curator of the Department of Living Invertebrates at The American Museum. Dr. Jones's specialty is investigating the taxonomy and distribution of polychaetous annelids, or marine worms.

The discussion of flying squirrels that begins on p. 18 is the work of Mr. Illar Muul and Mr. John W. Alley. Mr Muul is a graduate student of zoology at the University of Michigan and is working on the natural history of flying squirrels. Mr. Alley is electron microscopist and photographic consultant for the University's Department of Zoology. Mr. Alley made the majority of the photographs illustrating the article.

The author of "A Floral Inheritance," Miss Elizabeth Scholtz, is Assistant Curator of Instruction at the Brooklyn Botanic Garden, in New York City. Miss Scholtz, who studied botany at the University of the Witwatersrand, teaches identification of wildflowers and succulent plants of South Africa. She is particularly interested in wildflowers, and her hobby is photographing them.

An unusual and successful project to acquaint children with nature is described by Mrs. Hannah Williams in the article that begins on p. 32. Mrs. Williams was instrumental in establishing the Riverdale Outdoor Laboratories, and she has continued to devote much of her time to the organization. The photographs accompanying Mrs. Williams' article are the work of Mrs. Arline Strong, a nationally known photographer of children, and herself a resident of Riverdale with considerable interest in the project.

Dr. Fritz Schremmer, an entomologist, presents on pp. 42-45 a description of the strange posture a female centipede assumes to protect her eggs. Dr. Schremmer is a member of the staff of the Zoological Institute at the University of Vienna. He is an accomplished scientific photographer and his work has appeared several times in Natural History.

In "Music, Men and Gods," Mr. Colin M. Turnbull explores the origins of various types of musical instruments. Mr. Turnbull is Assistant Curator of African Ethnology in The American Museum's Department of Anthropology, and author of the recently published *The Lonely African*. In addition to his background in anthropology, he brings his abilities as a musicologist to bear on the subject of his article. Mr. Turnbull's bent for things musical has resulted in his acquiring a collection of harpsichords, which provide both aural and visual pleasures. Mr. Lee Boltin photographed the instruments that Mr. Turnbull discusses.

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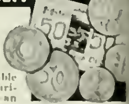

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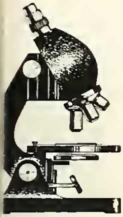

NATURE and the MICROSCOPE

Identifying fingerprints

By Julian D. Corrington

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In crime prevention and detection
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cation, document analysis, and ballis-
cs, each manned by specialists in the
eld. Local law officers send material to
e laboratories for analysis. The results
f such analyses are accepted as evidence
y all courts of law.

Among the many departments of the
rger detection bureaus, that of personal
dentification is one of the most impor-
ant. Throughout the world, countless
mes a day, it is imperative to identify
rrested suspects, accident victims, ca-
avers, and accessories to crimes.

THERE are in general three main chan-
nels for personal identification. The
amous one of Alphonse Bertillon,
rench anthropologist, 1853-1914, which
ears his name, is based on physical
easurements and the notation of de-
ormities, abnormalities, scars, color, and
ny other feature that may be out of the
rdinary. Thus, the shape of the ear,
ength of nose, proportions of the body,
resence of bunions, and so on might well
istinguish one person from another,
specially when the characteristics are
ssessed in combination. Bertillon's
escription of a person was virtually an
nthropometric catalogue of the individ-
al, and seldom would two people fall
nto identical categories.

A second identification method is psychological and is known as the *modus operandi* system. It was established by an officer at New Scotland Yard who worked on the assumption that a criminal, like all other persons, has personal traits and idiosyncracies, and that he cannot avoid displaying personal habits and mannerisms. Thus, a man who perpetrates a fraud is classified first by the character he assumed; second, by the class of person he defrauded; third, by the class of goods obtained; fourth, by the names, titles, nicknames, or aliases used; and fifth, by other peculiarities that may have been noted. One man will pose habitually as a physician, preying upon elderly, widowed, and wealthy women, seeking their money or jewelry; another will have a different *modus operandi.*

FINGERPRINT classification is the third system of identification and is far and away the most important. With a hand lens or pocket microscope or an inverted eyepiece from a compound microscope, look at the tip of one of your fingers. You will see a succession of ridges and furrows, like a distant view of a plowed field. The raised portions are friction ridges, the depressions are called sulci. This configuration is an antiskid device, analogous to the tread pattern on an auto tire. The ridges developed in ancient mammals and have come down to the present-day, prominent in some groups, less so in others, but nowhere more highly developed than in the Primates, the order to which man belongs. The tiger or wolf needs such ridges on the paws for sure-footedness on the ground; monkeys dwelling in trees need them to assure a firm, antiskid grip on tree limbs. In fact, the tips of long, prehensile tails of some monkeys are bare of hair and have "fingerprints" of friction ridges on the underside.

The fingerprints of man are less pronounced, but still show the ancestral pattern. There are five apicals at the tips of the fingers, four interdigitals at the bases where one finger joins another, a thenar at the base of the thumb, and a hypothenar at the bottom of the palm under the little finger. Corresponding areas of friction ridges exist on the foot, and babies are footprinted in hospitals to avoid mixups. Cummins and Midlo,

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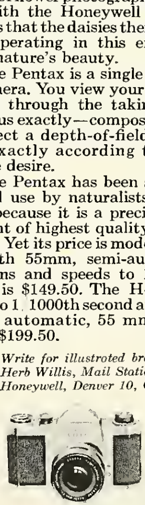

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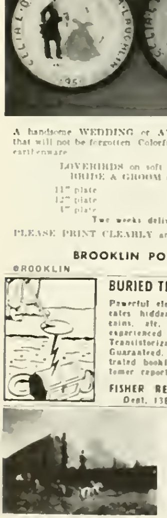

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in 1926, proposed the term dermatoglyphics as an inclusive word for all the skin patterns that are found on the fingers, toes, palms, and soles.

Pores of sweat glands open along the ridges and may be seen under high magnification. The perspiration will moisten the friction ridges, thereby increasing the sureness of the grip.

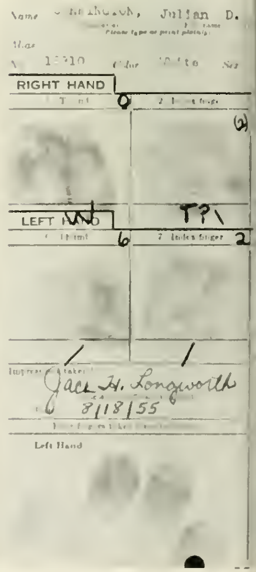
WHEN a given fingerprint is viewed under moderate magnification, the pattern of ridges and sulci presents such an astonishing number of individual complexities that the probability of its recurrence on any finger of the same or another individual is only one in several millions of chances. When the complete set of ten finger patterns is considered, the likelihood of a duplicate set appearing in another individual has been estimated to occur only once in 10,000 years. But now if we add the very detailed and intricate arrangement of sweat gland openings along the ridges – thousands of them in a single picture – it may readily be understood that not twice in the entire history of the world has a single human fingerprint, much less a complete set of the ten digits of an individual, ever been duplicated in every minute respect. Introduction of fingerprint evidence is now admissible in courts everywhere and the number of confessions and convictions obtained through this branch of forensic science grows each year.

Fingerprints do not change throughout life. They are the same in the fetus, the infant, the child, the adolescent, the mature and senile adult, and even on the cadaver. Mutilations made purposely to change fingerprints are of no avail; the fundamental pattern shows through, and the scars are themselves distinctive.

Fingerprinting was first proposed by Sir Francis Galton, cousin of Charles Darwin, and was elaborated on by Sir E. R. Henry when he was inspector general of police for the lower provinces of India. Since many Indians did not know how to sign their names to paychecks, a system of personal identification became necessary to prevent unscrupulous persons from making false claims, repeating, forging, and indulging in other fraudulent practices. Henry had them fingerprinted and began to study the enormous array of prints. He eventually worked out a method of classifying all the prints and thus arose the Henry system, still the basic one today, although some modifications and additions have been made. A newer one is the Battley system, devised to identify a single print. Now all armed services personnel, employees in banks and in many industries have their fingerprints on record. In fact, most fingerprints on file with the FBI and other authorities are those of non-criminal persons.

DR. CORRINGTON, who is well known in the field of microscopy, recently retired as Professor of Zoology at the University of Miami in Florida.

If you are fingerprinted, the offic who records your prints will take hol of your right thumb with the thumb an index fingers of each of his hands, an bring your thumb over a glass or porcelain plate on which printer's ink h been spread thinly with a roller. He wi place the thumb down on its left sid roll it to the right in the ink with moderate pressure, then lift it cleanly awa and carry it to a regulation fingerpri record card. The thumb is touched t the card left side first and rolled over t the right, then lifted away. This mak a rolled print of the thumb's frictio ridges, spreading them out and makin the pattern easier to read. The operato will repeat this procedure with each dig of the right hand, then the left. Whe the ten rolled prints have been finishe the four fingers of the left hand are applied simultaneously as stamped prints without rolling, then the four fingers o the right hand, then the two thumb together. The stamped prints, at the bottom of the card, serve as a check on th rolled prints, in case some one of ther might have been accidentally applie out of sequence. The card is then signe by the person printed, and data ar



Name [illegible], Julian D.
(Please type or print plainly)
Alias
No. 1[illegible]10 Color White Sex

RIGHT HAND
1. Thumb 0 | 2. Index finger (2)

T?\

LEFT HAND
6. Thumb 6 | 7. Index finger 2

/ /

Impressions taken
Jack H. Longworth
8/18/55

Left Hand

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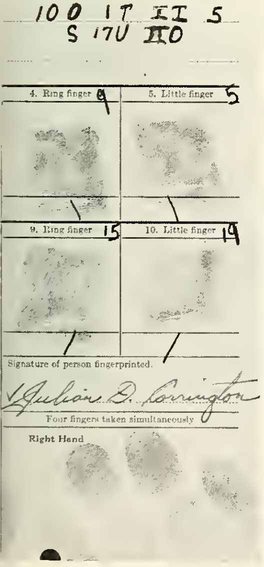
ded regarding age, height, weight, lor of eyes and hair, scars, tattoos or her distinguishing characteristics, the cknames and aliases used, if any, ad- esses, and any other pertinent data. As the fingerprints are recorded, the ficer will affix certain cryptic markings the corners of the square containing e prints. They are classification numbers, and the officer will finally place a compilation of them in the upper right corner of the card. This becomes the number under which the card will be filed, just as a Dewey decimal system number might be used in a library for filing a book. Any huge collection of items, whether books, stamps, microscope slides, butterflies, or fingerprints, must be systematized so that a particular wanted specimen can be found within a reasonably short time.



100 IT II 5
S 17U IIO

4. Ring finger 9
5. Little finger 5
9. Ring finger 15
10. Little finger 19

Signature of person fingerprinted.
Julian D. Carrington

Four fingers taken simultaneously
Right Hand

PRINTS are first broken down into four major classifications: arches, loops, whorls, and composites. In an arch, the ridges — passing across the print from left to right — run straight across at the base, but begin to rise into a symmetrical curve, ever higher toward the finger tip. Arches constitute 5 per cent of all fingerprints. Loops have certain ridges that start out from one side and then recurve and end on the same side, never passing across. If the recurving is toward the thumb side of the hand, the print is a radial loop, if in the opposite direction, an ulnar loop, named after the bones in the forearm. Some 60 per cent of prints are loops. If the ridges make complete circles or spirals, the print is a whorl, either single-cored or double-cored. Whorls account for 35 per cent of fingerprints. Composites include those prints that show features of two or more of the foregoing configurations.

In a loop there is a place where a single ridge, in approaching the central pattern, bifurcates, or two parallel ridges diverge. This point is termed a delta, or a triradius. Some authorities consider these terms synonymous, others make a distinction between them. The apex of the central rod or loop is the core, or point of core. Whorls have two deltas, one on each side. Ridge tracing is a most important means of further subdivision in print classification. It is done by laying a straightedge from delta to core and counting the ridges crossed by using a hand magnifier, a fingerprint microscope, or a wide-field binocular microscope.

The primary classification employs two divisions, arches being placed with loops, and composites with whorls, so that only loops (L) and whorls (W), as thus amplified, are recognized. The ten fingers are bracketed into five groups of two each in the following order: right thumb and right index; right middle and right ring; right little, left thumb; left index, left middle; left ring, left little.

If we consider the first pair, the four possible arrangements are L/L, L/W, W/L, W/W, and the same combinations are possible for each of the four other pairs. Since each combination of the second pair can be combined with each of the first pair, the possible combinations of the first two pairs, taken together are 4 x 4, or 16. The third pair has the same four possibilities, so that those of the first three pairs collectively become 4 x 16, or 64; with the fourth pair, 256, and with the fifth, 1,024, the total number of primary divisions of the system for all fingerprints.

ASSIGNMENT of arbitrary values to occurrences in this primary scheme enables the complete representation of a given set of finger impressions to be expressed as a single fraction. If a whorl occurs in the first pair it counts 16; if in the second pair, 8; third pair, 4; fourth pair, 2; and fifth, 1. Loops are counted as zero. Presuming that the formula in a given example would read:

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W L, W W, I W, L L, W L, the numerical value thus arbitrarily assigned would be: 16 0, 8 8, 0 4, 0 0, 1 0, which adds to a fraction of 25 12 One is then added to both numerator and denominator to avoid zeros in cases where only loops are present. The sum then becomes 26 13, and this is inverted to make 13 26, the primary classification.

Some of the numbers thus obtained are encountered rather frequently, and additional subdivision is necessary The two index fingers are next classed. U U meaning that each was an ulnar loop, R A that the right index was a radial loop, the left an arch. Next comes a fraction such as III IIO, in which the second, third, and fourth digits of the right hand form the numerator, and of the left hand the denominator. This describes whether the lower bifurcating ridge from the delta (the left delta in whorls) passes inside (I), outside (O), or meets (M) the corresponding ridge from the opposite side of the print. A fraction such as 5 19 describes the ridge-tracing counts — from delta to core — of the two index fingers. Further classifications are used in cases where many prints fall into a single category. Our final number might resemble the following: 1 17 U U IIM OOI 5 19.

There is a great deal more to the classification system than can be discussed in a brief article, but it is apparent that an expert operator can locate a wanted print in a minimum of time. Prints and codes can be flashed from one file center to another, and identifications of both the criminal and non-criminal can be made rapidly and positively.

One of the most important of all instruments used for fingerprint work is the comparison microscope. This usef tool of forensic science has two objec tives but only one eyepiece. The ima from the left objective might, for exam ple, be that of a fingerprint lifted wit adhesive tape from a polished waln table; that from the right objectiv might have been obtained by fingerprin ing a suspect. The two images pass u through a prism system and are delivere to the eyepiece, side-by-side, separate by a central hairline. If the two imag can be matched across the mid-line s that every ridge continues across th print, it is absolutely conclusive evidenc that the two prints were made by th same finger. If they do not match, the were not made by the same finger. Her it should be emphasized that the fun tion of the forensic scientist engaged b a law enforcement agency is not to prov the guilt of an accused person or t supply the police with evidence that wil convict, as is commonly supposed. O the contrary, his duty is to the cour rather than to the police: he is to furnis the court with all available scientif evidence, whether this evidence speak for or against the accused. And ther are many cases on record where the sci entist's findings have proved innocence

This list details the photographer, artist or other source of illustrations, by page

COVER—AMNH Archives
4—Joseph Sedacca
10-17—AMNH Archives
18—Leonard Lee Rue III
19—C. G. Hampson
20-25—John Alley
26—South African Tourist Corp.
27—Elizabeth Scholtz
28—top, Ely Fehrer; center, H. B. Rycroft; bottom, E. Lotter
29-31—Elizabeth Scholtz except 29-top, South African Tourist Corp.
32-41—Arline Strong, except 34-bottom, Hubert Birnbaum
42-45—Fritz Schremmer
47-53—Lee Boltin
54—AMNH Archives
56—AMNH
58-59—Carolyn Carter
62-63—Julien D. Corringto

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To these [illegible] the [illegible] body [illegible] completely hairless except for the hair of the head which is valued highly. This Urca mother is removing her son's eyebrows by knotting a thread over each hair and quickly pulling on it.

Ceremonial costumes are an essential aspect of religious rites. They are made and [illegible] in the masking house reserved for men only. Women who attempt to penetrate the mysteries of the masking house are brutally punished.

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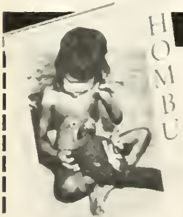
The Craho tribe conducts daily relay races which are much the same as ours except that they are for more strenuous. The relay "baton" weighs as much as two hundred pounds!



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Natural History

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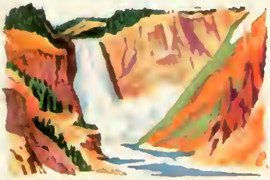
YELLOWSTONE
where Nature has outdone the Wizard of Oz

Not even the Emerald City of Oz had such wonders as Yellowstone National Park in Wyoming. This is Castle Geyser

Yellowstone National Park in Wyoming is so unbelievable that when C. W. Cook wrote of his explorations there in 1869, *Lippincott's* Magazine refused such "fiction." Who could believe things like hot water spurting 200 feet high, glass cliffs and rivers that leaped off mountain tops? Or forests whose trees had turned into jewels?


Falls and Grand Canyon of the Yellowstone

But this Land of Oz is real. This wonderland, unique in all the world, has been forever set aside so that Americans may enjoy its strange beauty. There are 3,000 geysers and hot springs; "Old Faithful" hisses, snorts and blasts tons of water into the air on regular schedule. There's a cliff of black volcanic glass. The falls of the Yellowstone River are twice as high as Niagara. There are more than 24 layers of petrified trees whose wood has become opaline veined with amethyst.

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Yellowstone is our National Park masterpiece, a *shining example of conservation's worth to both man and Nature.* Tok
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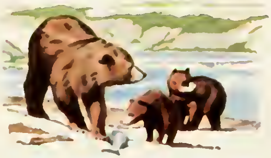
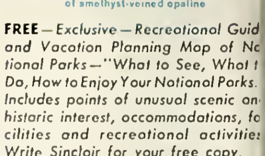

Bears aplenty in our greatest wildlife refuge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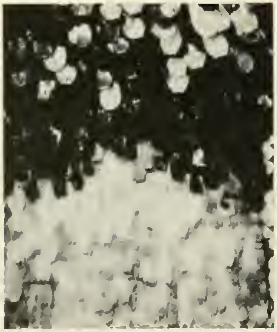

COVER: At first glance—and, perhaps, even at second—this composition an color could easily be mistaken for an expressionist painting. Instead, it is living subject, caught by a camera, and shows the scalation of *Castni eudesmia*, a Chilean moth of the family Castniidae. Members of this famil are large and day-flying. The scales, too, are large, and so show clearly thei changing iridescence. Many of the *Castnia* species are most striking mimic of various butterflies with highly protective coloration that fly in the same area For some of the "whys" of Lepidoptera scale color, please turn to page 30

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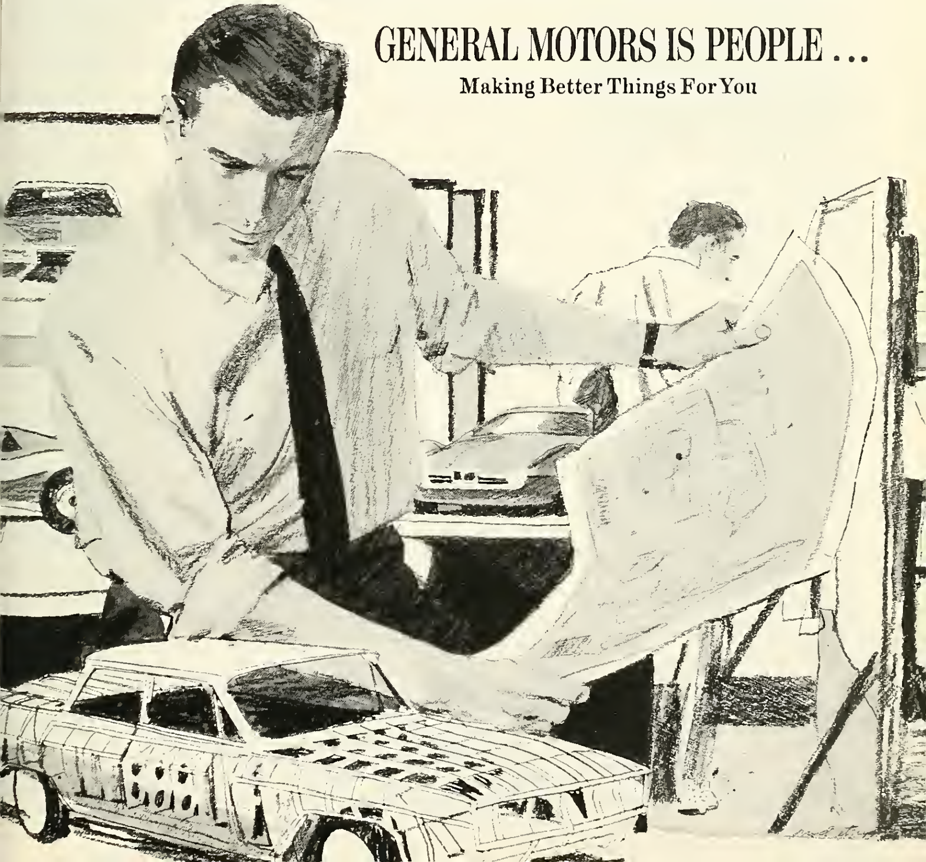

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by Raymond F. Dasmann

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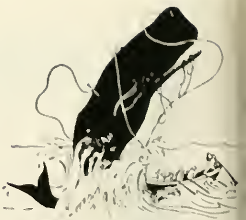
Reviews

History, hunting, and voices of leviathan



By Richard G. Van Gelder

WHALER'S EYE, by Christopher Ash. *MacMillan Co., $7.50; 245 pp., illus.* WHALES, by E. J. Slijper. *Basic Books, $12.50, 445 pp., illus.* WHALE AND PORPOISE VOICES (L.P. record), by William E. Schevill and William A. Watkins. *Woods Hole Oceanographic Institution.*

If man's first knowledge of the larger whales came from an animal stranded on the shore, his initial interest was, undoubtedly, in the tons of available food. Whole tribes probably camped beside carcasses until they were eaten or had become so foul they drove men away. How long ago in prehistory man first became aware of whales is hard to say; the earliest known evidence of his familiarity with them is a rock carving in Rödöy, Norway, dated at about 2200 B.C.

From an initial stage of carrion feeding, the next step in whaling might possibly have been herding whales in such a way as to cause them to run aground where they could be slaughtered—a marine version of the Plains Indians driving bison herds over a cliff. (A similar primitive but effective method persists today among the Faeroe Islanders of the North Atlantic who annually herd blackfish ashore for food and oil.)

Eventually, more venturesome mariners probably started harpooning the smaller whales, and finally whaling in open boats came to be a regular industry in those parts of the world frequented by sufficient numbers of the animals to make the industry profitable.

The increased development of seagoing vessels led to the pursuit of whales farther and farther from shore, and these ventures raised problems not faced in shallow waters. Not all whales float when dead, thus profitable whaling demanded the selection of species that floated. Because the lack of refrigeration facilities prevented storage of fresh meat, emphasis had to shift to the more profitable products of oil and of baleen, the horny, flexible plates that hang in rows from the upper jaws of some whales and were used for such items as corset stays.

As early as 1619 the Dutch had established a tryworks on Spitsbergen for oil production, and the abundant whales that frequented the bays of that island were killed and hauled to the boilers. As this industry made inroads into wh
populations (more than 1,000 men w
employed at the tryworks alone),
whalers had to work farther and fart
from shore, making it necessary to do
flensing at sea, where the blubber w
packed in barrels for later renderi
From here it was only a short step to
factory ship, which was first tried s
cessfully about 1600.

Christopher Ash's book, *Whale
Eye*, is about modern whaling in
Antarctic. In fifteen short chapters
personalized essays, Mr. Ash has c
tured the flavor of the Antarctic whali
season—the ships, the whales, the m
the industry, and the environment.
vast amount of information is present
not only for the biologist and whal
buff, but for anyone interested in g
reading. If a criticism may be raised
is that the reader's appetite for infor
tion is whetted, but he is not really
Half the book is given over to ph
graphs that complement the text bea
fully, and in common with the text, le
the reader wishing for more. One mi
also have hoped for better reproduct
of the photographs.

Near the end of *Whaler's Eye*,
Ash engages in an argument with
imaginary antagonist to justify the wh
ing industry and its practices. This
one of the weaker parts of his book, a
its inclusion implies more questions
Mr. Ash's mind than were in his

MANKIND'S information about
classification, anatomy, physiolo
behavior, and ecology of whales has l
ged far behind his techniques for th
capture and exploitation. Long confu
with fish, whales were correctly classif
as mammals by Linnaeus in 1758, a
there is no further argument on this s
ject. There are two major divisions
whales: the toothed whales and the
leen (or whalebone) whales. The tooth
whales are predators of the sea, from
sixty-foot long, squid-eating sperm wh
all the way down to the four and one-h
foot long porpoises. The baleen wha
lack teeth and are grazers, feeding on
small organisms they strain from
water through horny baleen plates.

Most of the whales of commercial i
portance are baleen whales, from a 1

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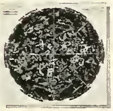

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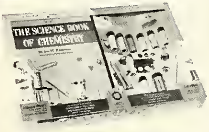

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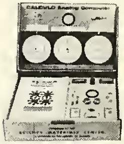

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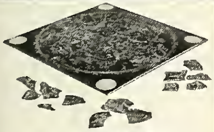

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foot blue whale down to the twenty-foot pigmy whale. Early whalers noted the differences of the floating characteristics of some whales. "Right" whales were so named because they floated when dead, had good blubber, and much baleen, and were thus "just right" for whaling; they were hunted almost to extermination. Other behavioral and physiological differences have proved important, including voice. The beluga, for instance, was known as the "canary of the sea" because of its audible sounds.

Most of the non-commercial scientific information about whales has been accumulated in the twentieth century, and there has long been the need for a book that would bring together much of this recent information in an authoritative and integrated fashion. E. J. Slijper's *Whales* is a fine introduction.

Starting with a concise history of man's interest in whales, Slijper follows with chapters on evolution and external appearance, locomotion and locomotory organs, respiration, heart circulation and blood, behavior, hearing, production of sounds, senses and central nervous system, feeding, metabolism, distribution and integration, reproduction, the future of whales and whaling, and classification of the Cetacea. *Whales* is an interesting combination of technical material popularly written; it most closely approximates a textbook in its mode of delivery, exposition, and illustrations, and thereby is suitable for scientists and laymen alike. It contains a vast quantity of fascinating information.

Specialists will disagree with fine points in Slijper's text and some interpretation. It is most sad that Slijper has resorted to the frequent use of common names throughout his text—a device that decreases the value of his work. The perfect example of this is on the first page of text matter where an "elk" is mentioned. Americans will recognize the depicted animal as a "moose." Systematists will also object to the classifications in the last chapter. Conservationists will surely be dismayed by the philosophy in the chapter on the future of whales and whaling. But despite these shortcomings, *Whales* is a summary essential for the naturalist's library shelf.

WITH the use of underwater detection gear developed in World War II and since, man has learned that the world beneath the sea is far from silent. Early work on the detection and identification of underwater sounds was limited to the wartime effort to distinguish submarines from other noises. Then came attempts to determine the species of animals producing sounds, and the subsequent discovery that some whales use underwater sounds both as a refined means of orientation and for the detection of objects near them under the sea—

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id probably also for communication nong themselves. This last aspect has sulted in misguided publicity, which iggests that some whales can talk intel-gibly to some humans. Most qualified ologists have good reasons to doubt e validity of the scant data portending substantiate such "conversations."

Far more interesting and better docu-ented. if not as imaginative. is the cord *Whale and Porpoise Voices* made William E. Schevill and William A. atkins. Here. on a single long-playing cord are presented some of the sounds ade by eighteen species of whales. all it one of which were recorded at sea. ie tremendous variety of sounds pro-iced is startling—clicks. squeals. bird-e whistles. and something strongly miniscent of a "Bronx cheer." Accom-inying the record is a twenty-four page implet of complementary explanation id description. In the best of scientific adition. no attempt has been made to ve premature interpretation (imagina-e or otherwise) to these sounds: only ter the long accumulation of data will be possible to say more about what ese sounds actually represent. The cord is not commercially available. it has been distributed widely to quali-d scientists throughout the country.

Mankind seems unwilling to learn om past experience, and the future of iales and whaling seems destined to peat the sad histories of the American son and the great game herds of frica. Man takes action to preserve ecies only at the last possible moment. id his preservation action is usually ised on such scant data that it is a onder some animals have survived at l. Both the Slijper and Ash books sug-st that whaling is no exception.

The International Whaling Commis-on attempts to regulate whaling with view to perpetuating whales at a level at is economically profitable. Whaling iotas are allotted in "blue whale iits," with two or more smaller whales jualing one B.W.U. Already the stocks blue whales have been so reduced that i whales make up the majority of any odern catch. Since it takes two fin hales to equal one blue whale unit, ore whales are being killed now than eviously. Moreover, the reduced blue hale populations are not afforded otection and are exploited at any eco-omically feasible opportunity. Pre-imably, whalers will shift to smaller id smaller whales, so long as profitable, make their quotas, and the use of naller whales will mean greater num-rs of animals killed.

Given protection, some species of hales have shown that they can rebuild eir numbers. The protection of the ght whales since 1929 has allowed em to rebuild their population, and e gray whale, protected for twenty-five

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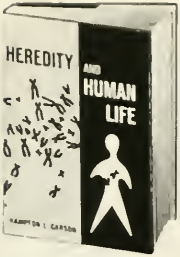

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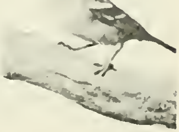

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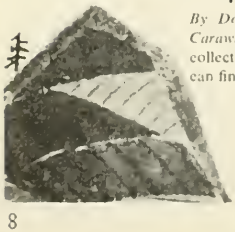

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years, has increased from two hundre to more than six thousand. Obviously the happy medium is for detailed studie of the reproductive potential of eac species to serve as a guide to the whaler so that a large breeding stock can b maintained and the surplus harveste

Only intelligent acquisition and utilization of biological data will assure th preservation of the whale population

Dr. Van Gelder is both the Chairman an Associate Curator of the Department o Mammalogy at The American Museum

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HOMBU, by Harald Schultz. *The Macmillan Co., $12.50; 126 pp., illus.*

This book is a collection of photographs taken by Harald Schultz ove a period of twenty years during visits t nine Indian groups in Brazil. Most o these groups are still isolated from civilization and maintain their aboriginal wa of life. The photographs are superb i both clarity and composition, and th subject is the most interesting in th world—human beings with exotic cu toms. This combination makes the boo extraordinarily attractive.

The author's purpose, far from parac ing the sensational aspects of primitiv life as primordial savagery, is "to brin to the reader that which is human i the Indian, that . . . [which] unites a mankind. . . ." This purpose is admirabl achieved by pictures that portray th needs, anxieties, curiosity, pride, an joy of the Indians in their work and re reation. But the charm of the collectio lies not only in what is universal t people but, more especially, in what peculiarly Indian—their distinctive way of meeting common human needs. In a dition, the book reflects the warmth o Schultz's own feeling toward the Indian and a respect born of understandin

The photographs are complemente by brief sketches of the nine tribes an individual explanations of the picture If one wishes to gain more than ente tainment it is necessary to read th textual material. The author does no pretend to write a scholarly work. Neve theless, there is much here that is o value to the student of South America tropical forest peoples, because Schult has visited and recorded the customs of number of tribes whose cultures are stil little-known to ethnologists. The descrip tive material is lumped together in a sec tion apart from the pictures, presumabl for economy of publication. Much is los through this organization, since th reader will be tempted to peruse th photographs without going to the con siderable inconvenience of turning bac constantly to consult the descriptions

Translation of the text from the original German has resulted in some technical difficulties, such as awkwardness of expression, inconsistencies in the spelling of tribal names, and a few errors. However, the quality of reproduction does justice to Schultz's excellent photographs.

GERTRUDE E. DOLE

LIFE IN THE UNIVERSE, by Francis Jackson and Patrick Moore. *W. W. Norton & Co., $3.95; 140 pp., illus.*

THIS collaboration of two talented scientists deals, as the title indicates, with the possibilities and probabilities of life either on other bodies in our solar system or elsewhere in the universe. Dr. Patrick Moore is a well-known and prolific writer and interpreter of astronomy. He is undoubtedly responsible for the astronomical side of this presentation, and it is well written, logical, and eminently understandable. Dr. Francis Jackson is the biological expert of the team, and his writing is equally good, his logic is sound, and what he writes is highly interesting.

Dr. Moore gives the conditions and the environment found on the various planets of our solar system, and outlines the essential needs for the origin and continuance of life. Dr. Jackson describes in fascinating detail the various forms of living systems and tells why such systems must have the essentials described by Moore. The various probabilities for the arrival of living organisms on a hospitable host are outlined. Their conclusion is that in our own system the earth is the only possible location for what we laughingly describe as intelligent life.

There is, as Moore points out, an abundance of stars of the solar type in other parts of the universe. When and if we ever learn how the sun acquired its family, we will be in a better position to state whether any of these stars has undergone the same evolution as the sun. The consensus among astronomers is that there must be literally millions of stars possessing planets upon which conditions exist that make life possible, and that many of these planets must be inhabited. The factory is just too big for so small a product as the earth alone possesses. But, as Dr. Moore points out, the chances of our meeting any of these hypothetical neighbors is as remote as they are.

Man's present efforts to communicate with possible planets that may orbit two of the nearer solar-type stars are touched upon and, in the final section, the possible future of our own planet is described. This is good, solid reading and details a situation that has been touched on superficially by many astronomers.

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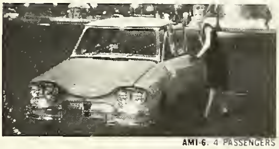

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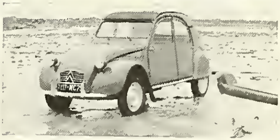

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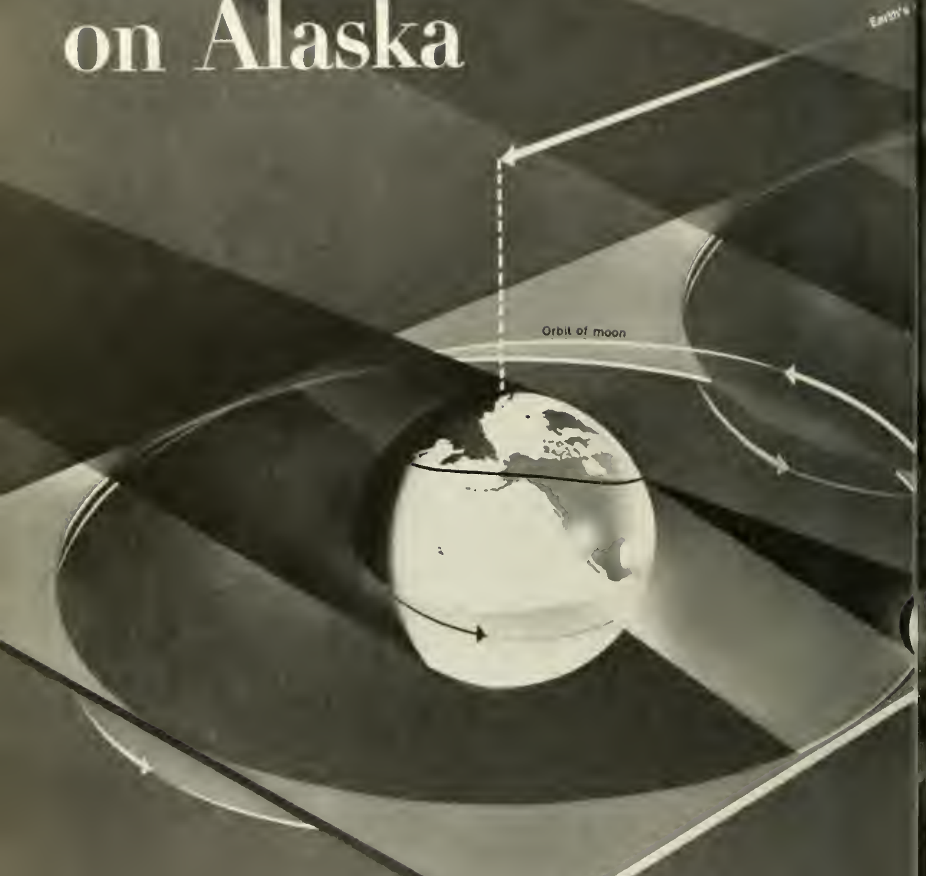
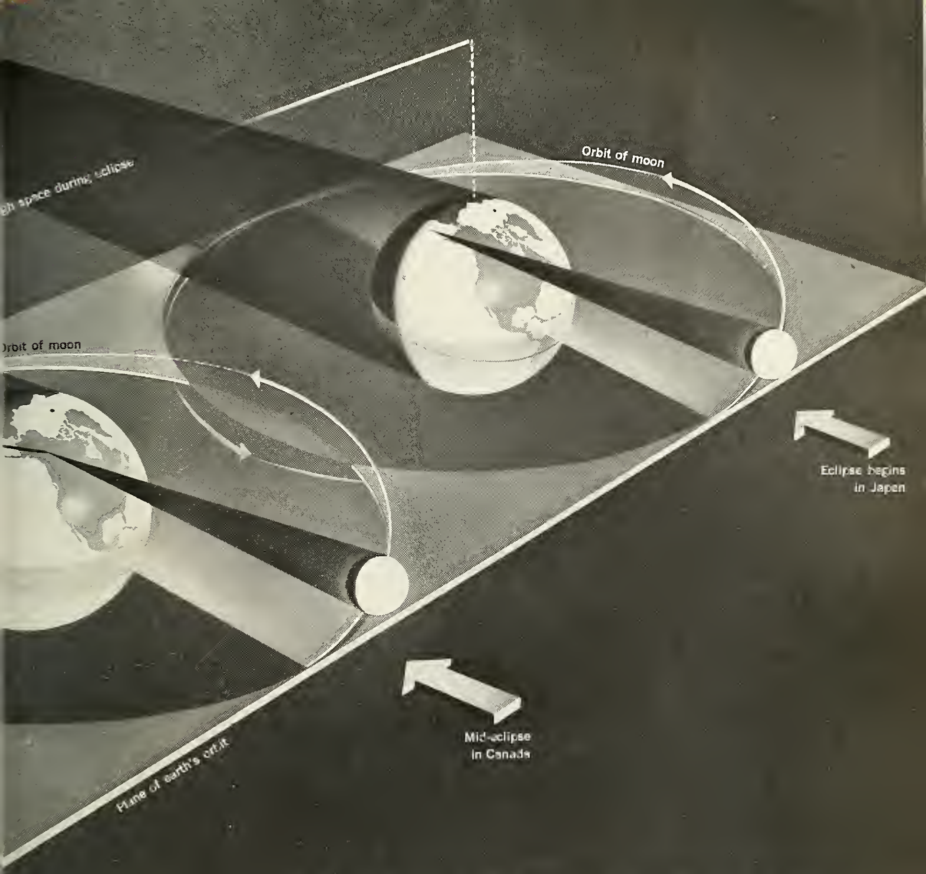


Motions of earth and moon during eclipse of July 20 are shown from right to left. During nearly 2¾ hours that the moon's shadow touches earth, earth advances in orbit more than 1.6 million miles and rotates through 41¼°; the moon advances in orbit around earth about 5,700 miles. Path of moon's shadow across the earth is result of these motions.



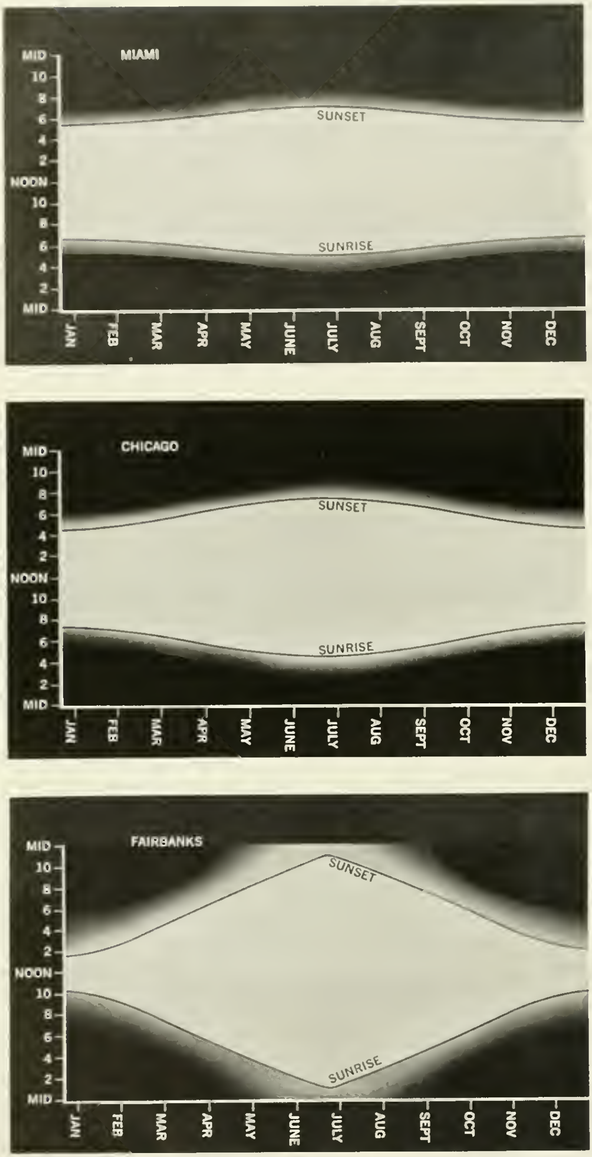
July eclipse will traverse northern regions

By THOMAS D. NICHOLSON

Drawings by HELMUT WIMMER

MORE ASTRONOMERS are to visit Alaska this summer than at any other time in the history of that region. Knowing in advance that a total solar eclipse will occur in Alaska on July 20, 1963, the American Astronomical Society accepted the invitation of the University of Alaska to hold the summer 1963 meetings at College Station, near Fairbanks. The astronomers who attend the meetings will have an opportunity to observe the first total eclipse of the sun seen in this country since June 30, 1954, and the last one that can be seen until March 7, 1970. (The eclipse of October 2, 1959, which began at sunrise in eastern Massachusetts, was obscured by clouds.)

Although the eclipse will be the astronomical highlight of the summer, those who journey to Alaska can view many other unusual astronomical features from our northernmost state. It is, for example, the only part of our country from which the sun can be seen at midnight and the full moon at noon. Sun and stars cross the Alaskan skies in a manner that appears different to visitors from the south, and the night sky is often brightened by glowing auroras. Even time is different in Alaska because of the longitude, and

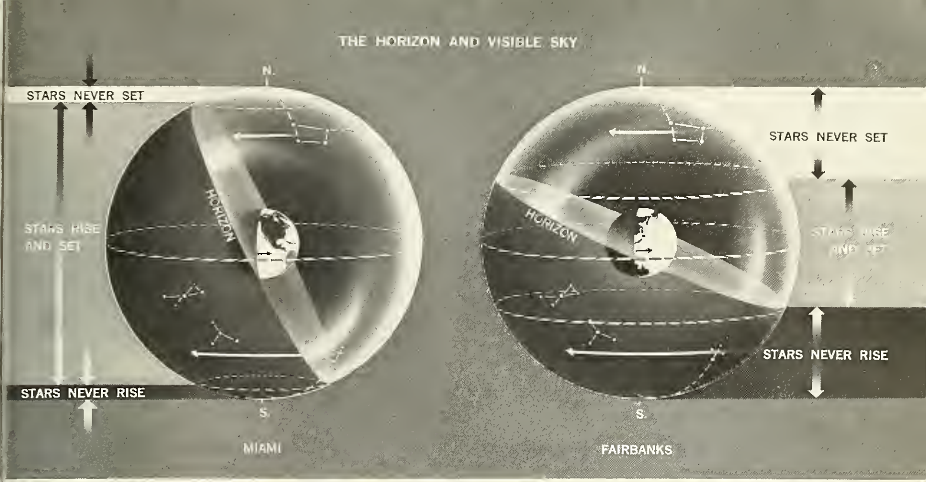


Duration of day, twilight, and night (light, shaded, and black areas) are graphed for three cities. Curves plot sunrise and sunset (local mean time). Twilight is longest in summer, but is nearly uniform through year at Miami. It is continuous from sunset to sunup at Fairbanks from Apr. 7 until Sept. 3.

the state's latitude gives its cities the longest days, the longest nights, and the longest twilights of any city in the entire United States.

The admission of Alaska as the forty-ninth state on January 3, 1959, produced many changes in vital statistics of the United States of America. Prior to that date, all of the states were within the North Temperate Zone of the Western Hemisphere. With the admission of Alaska, the United States expanded simultaneously into the Eastern Hemisphere and into the Arctic Zone. The admission of Alaska increased the total land area of the United States by about one-sixth, but at the same time it more than doubled the total coastline of our country (from 5,743 miles to 12,383 miles) and added another ocean (the Arctic) to the waters that border our shores. Alaska had little effect on the population total of the United States, but its admission did shift the geographic center of our country more than had the admission of any other state (from Smith County, Kansas, to Butte County, South Dakota, a distance of 354 miles northward and 264 miles westward). The geographical center of our nation is now within 278 miles of the Canadian border.

Astronomically, Alaska is the most peculiar of all the states. Since it extends above the Arctic Circle, the northern section experiences total day for several weeks each summer, during which the sun is visible at midnight. Then, for several weeks each winter the sun never rises and the ful moon, visible even at noon, never sets South of the Arctic Circle, however the sun rises and sets every day of the year, but may be visible only briefly at certain times. At Fairbanks, for example, the sun is in the sky for twenty-two hours and three minutes on the longest day of the year, June 21, and for only three hours and thirty-four minutes on the shortest day of the year, December 22. But from April 7 to September 3, even though the sun may set each day, Fairbanks never actually experiences a true night because twilight continues all night long. Even in the winter, the true night at Fairbanks is never longer than about thirteen hours, because twilights in the winter are more than three hours and forty minutes long. This is longer than the twilight in any other city in the United States at any time of the



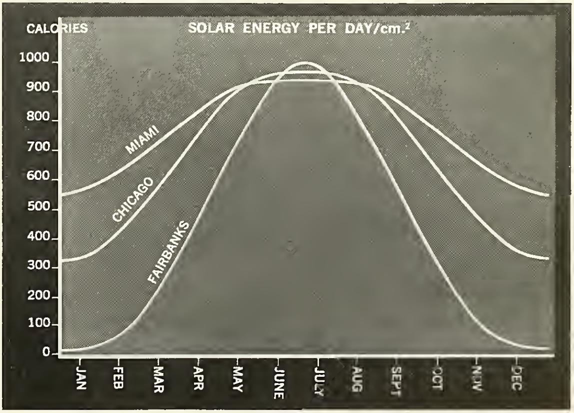
Stars over Miami, left, including the Big Dipper and the Southern Cross, rise and set in nearly vertical paths. At Fairbanks, stars cross the sky on nearly horizontal paths. The Big Dipper never sets, the Southern Cross never rises.

year. At Fairbanks on July 20, the day of the eclipse, the sun will not dip more than 5° below the horizon, so the city will not become even dark enough to require street lights or automobile headlights. This condition prevails each year from about May 15 to approximately July 27.

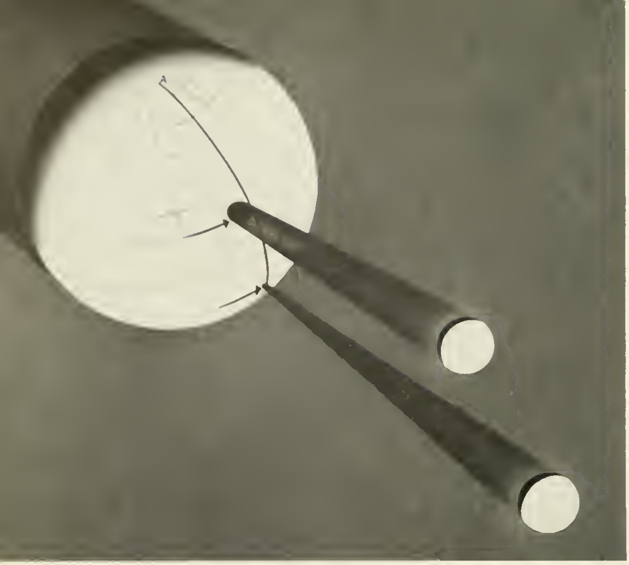
Because of very long days during Alaskan summers, the total solar energy available per day in most of Alaska is greater during some months than in any other part of our country — even greater than at the Equator. Although the summers are short, the long hours of sunshine each day can support a thriving agriculture and can produce daytime temperatures in the nineties. The Alaskan summers would be the hottest of the entire nation were it not for the moderating effect of the Pacific and Arctic oceans and the absorption of much of the solar energy as it passes through the atmosphere at relatively low angles. The moderating effects of the nearby oceans are also felt in the winter, of course. Except in the tundra region above the Arctic Circle, most of Alaska does not have a true Arctic climate. The central regions of the state, climatologically, are much more similar to the northern Great Plains states than to the Arctic.

Latitude, of course, affects the astronomy of Alaska. There stars cross the night sky in long, nearly horizontal arcs. Many stars known well in Chicago, Los Angeles, and Jacksonville are never seen at all at Fairbanks, while many stars that rise and set when observed in other cities appear circumpolar to the observer at Fairbanks. Like the North Star and the Dippers, they circle endlessly in the sky, never rising or setting.

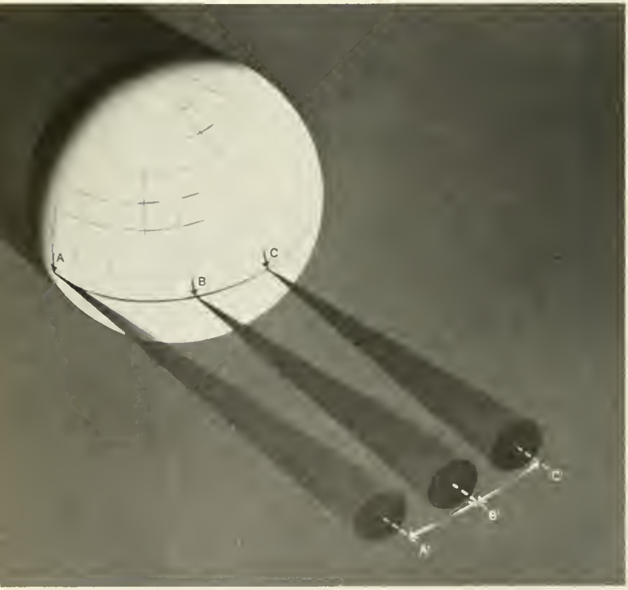
But longitude produces an effect, too. Because of the convergence of the meridians at high latitudes, the state of Alaska actually encompasses a greater difference in longitude than did the entire United States before Alaska's admission to the Union. And Alaska, with four time meridians within the state, nearly doubled the number of time zones used in our country. To the original Eastern, Central, Mountain, and Pacific Standard Times were added a Yukon Standard Time (135°W.), an Alaska Standard Time (150°W.), and a Nome Standard Time (165°W.). The fourth Alaskan time zone, based on the 180th meridian, which runs through the Aleutians, was not adopted because there



Solar energy through year is shown at Miami, Chicago, and Fairbanks. For approximately four weeks in June and July energy is greatest at Fairbanks.



SIZE OF MOON'S SHADOW on the earth, which affects the duration of eclipse, depends on distance between the earth and the moon. Large shadow takes more time to move across a given meridian (A) than the small shadow would take.



SHADOW OF MOON on earth moves fast at A (eclipse at sunrise), slower at B (eclipse about 10:00 A.M.), and most slowly at C (eclipse at noon) because of earth's curve. Shadow speed in space from A' to B' is same as from B' to C'.

are not enough people in the area
justify using it. Alaska is the on
state in our country in which a co
mercial airliner could actually out
the sun. By the clock, a jet aircra
flying from Fairbanks to Nome cou
land before it took off.

In Alaska the eclipse will occur du
ing the late morning hours of Ju
20. The most accessible places fro
which to observe it lie in the easte
part of the state, where one railro
and three highways provide access
the sixty-four-mile-wide path of tot
ity. The center of the total eclipse zo
crosses almost exactly over the tow
of Talkeetna, on the Alaska R.R li
from Fairbanks to Anchorage; Sou
dough, on the Richardson Highwa
and Slana, on the Glenn Highwa
Farther east, the path of totali
crosses into Canada near the poi
where the Alaska Highway crosses t
border. The astronomers attendi
meetings at Fairbanks will probab
view the eclipse from Sourdough
from the Alaska Highway, near t
Yukon Territory border. At Sou
dough, the total eclipse will occur
about 10:20 A.M., Alaska Standa
Time. At totality, the sun will be
an altitude of about 45° and will
located in the direction of SSE. Tot
ity will last, at Sourdough and poi
nearby, for about ninety-five secon

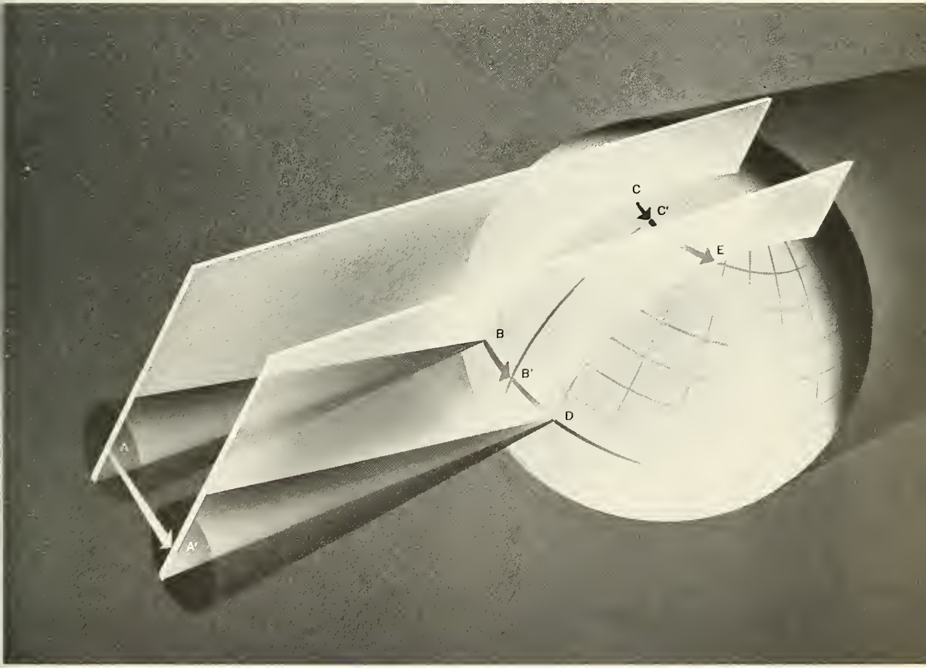
The rather short duration of t
eclipse – nowhere along its path d
totality exceed one hundred seconds
severely limits the nature of studi
that can be carried out during t
event. It is only during the period
totality, when the moon complet
covers the sun's photosphere (t
light-producing surface we obser
visually), that the otherwise invisi
features of the sun's outer structure
the chromosphere, the prominenc
and the corona – can be observed u
der normal circumstances. Althou
there is sufficient light in the chrom
sphere and in the inner corona
produce useful data during brief o
servations, this is not true of t
fainter outer corona and faint sta
around the eclipsed sun, which can
successfully studied only when perio
of totality are long – several minut
at the minimum.

Under the best circumstances, tot
ity can last roughly seven and one-h
minutes – four and one-half times
long as the greatest duration duri
this summer's eclipse. The durati

of totality depends upon how long the moon's shadow takes to pass over a point in its path, and this depends on the size of the shadow and the speed with which it travels over the earth.

The size of the moon's shadow where it touches the earth can vary from a mere point to a circle approximately 167 miles across. The size depends on the moon's distance from earth at the time. Since the orbits of the moon around the earth and of the earth and moon around the sun are both elliptical, the earth-moon distance and the size of the moon's shadow both vary. Because the sun is an extended rather than a point light source, the largest shadow will be cast on the earth when the earth is at aphelion (greatest distance from the sun) and the moon is at perigee (closest to earth) at the same time. Under these circumstances, the moon's shadow cone will be about 235,700 miles long, and the moon will be about 221,600 miles from the earth. The earth reaches aphelion in early July each year, so the longest eclipses are July eclipses when the moon is at or near perigee. The perigee moon occurs on July 16 this year. At the time of the July 20 eclipse, the moon's shadow cone will be very nearly its longest, but the earth will be about 233,500 miles from the moon. Therefore, the shadow cone intercepted by the earth's surface will be approximately fifty-three miles across, which is much smaller than is theoretically possible.

The speed with which the moon's shadow travels over the earth's surface depends on the latitude at which the shadow touches the earth and the time of day where the shadow falls. The speed of the moon's shadow through space, with respect to the earth, varies slightly with the position of the moon in its orbit, but we may take it to be very nearly 2,100 miles per hour, in an eastward direction. Where the shadow touches the earth, we find the earth rotating eastward, in the same direction as the motion of the shadow. The net velocity of the shadow over the earth, therefore, is the difference between the speed of the shadow in space and the speed of the earth's rotation. At the Equator, the earth rotates at about 1,040 miles per hour. The moon's shadow, when it touches the earth on the Equator, moves at a speed of about 1,060 miles per hour (2,100 minus 1,040). At high latitudes, however, the speed of the earth's rotation is considerably less. It is only about 440 miles per hour at the latitude of Fairbanks, Alaska (65° N.), for example. Consequently, the speed of the moon's shadow at this latitude will be about 1,660 miles per hour (2,100 minus 440). At the Equator,



Arrows show motion of moon's shadow through space (A-A′) and the rotation of the earth (B-B′ and C-C′) in one hour. The meridian B-C moves to position B′-C′ during this time. Eclipse at the Equator travels from B′ to D (1,040 miles) in one hour. Eclipse at 60° N. Latitude traces a path from C′ to E, distance of 1,680 miles, also in an hour's time.

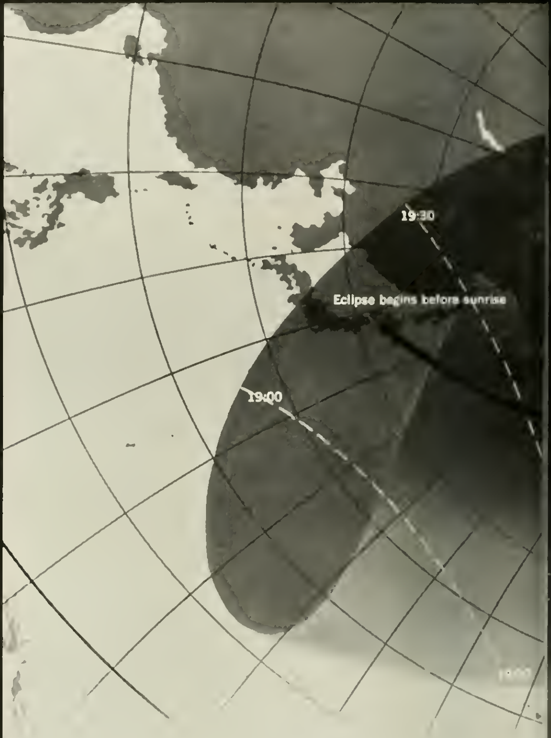
therefore, the shadow of the moon will pass a point more slowly than it will pass a point at higher latitudes. Thus, the longest eclipses are those that occur in equatorial regions.

But the duration of totality in any particular eclipse will vary from point to point within the shadow path. The longest duration will occur in the center of the shadow path, at the point where the eclipse takes place at noon. At that moment, the direction in which the moon's shadow moves on earth will be the same as its direction in space, and the speed of the shadow on earth will depend upon the latitude, as described above. At any other time during the eclipse, the shadow of the moon on earth will be moving on a surface that curves away from the earth-moon direction. The projection of the moon's shadow on the earth's curved surface causes the shadow to move across the earth very rapidly at places where the eclipse occurs several hours before or after noon. The shortest duration of totality occurs where the eclipse takes place at sunrise or sunset and the shadow of the moon is racing across the earth at four thousand to five thousand miles per hour.

SHOULD all circumstances favoring a long eclipse combine, totality could last for about seven and one-half minutes. This maximum duration was closely approached at the eclipse of June 20, 1955. The circumstances of that eclipse were almost ideal, with earth near aphelion, moon near perigee, and eclipse occurring in equatorial regions. The duration of totality exceeded seven minutes on the Malay Peninsula and the Philippine Islands. Unfortunately, cloudy weather prevailed in most places along its track, ruining the ambitious observing plans that had been made. As for the eclipse of July 20, 1963, the weather outlook in Alaska, eastern Canada, and Maine is at least encouraging, although it is not the best possible.

After the moon's shadow leaves Alaska, on the morning of July 20, it will proceed eastward through Canada and re-enter the United States at the Quebec-Maine border. Most of the eclipse path in Canada passes through remote regions. There the weather outlook is not very favorable. In eastern Canada, where the path goes through Ontario and Quebec provinces, and in Maine, the path of totality is again easily accessible, as it crosses many towns and cities, and a popular summer travel region.

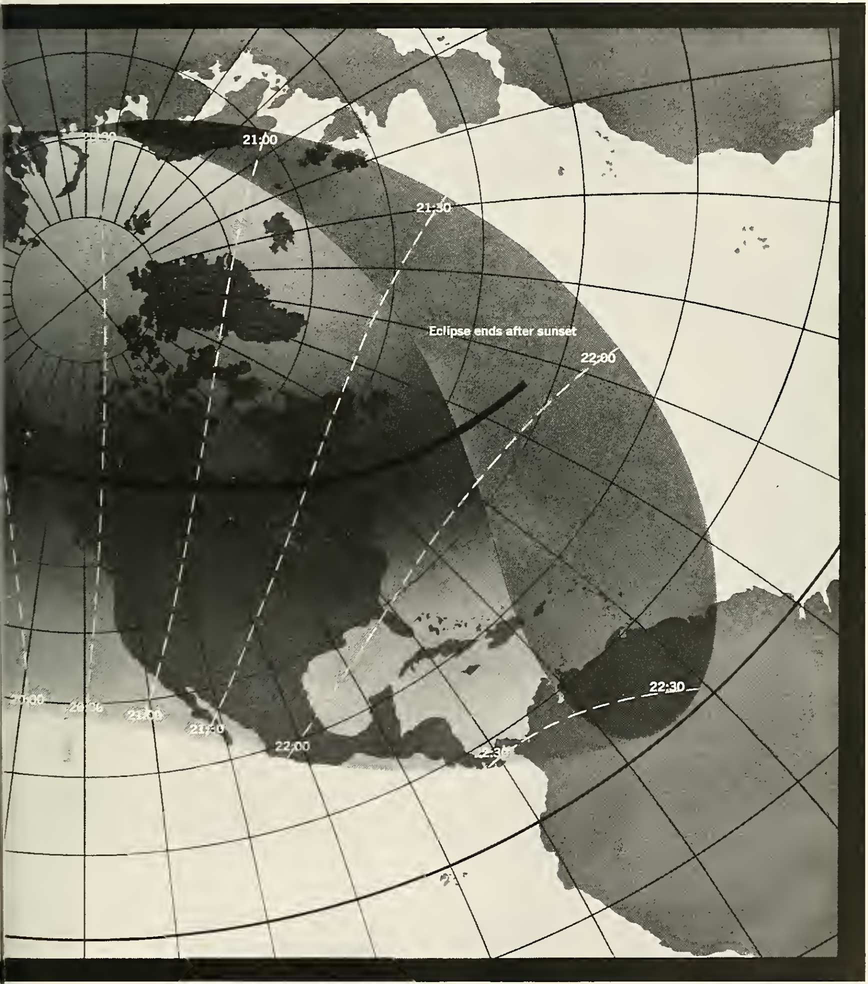
The total eclipse zone in Maine includes the three towns of Cambridge, Dexter, and Newport, the large city of Bangor, and the Bar Harbor resort. It will occur in the late afternoon, with totality about 4:42 to 4:44 EST (5:42 to 5:44 EDT) depending on locality. At totality, the sun will be almost directly west at an altitude of about 25° above the horizon. The duration of totality, in the center of the path, will be about one minute or a few seconds longer. Weather statistics indicate that the state has a better than average chance of clear skies for the event. More detailed information, including a map outlining the total eclipse region in Maine, is available from the Maine



SOLAR ECLIPSE of July 20 is plotted on map. The eclipse will be partial in shaded area and total along the solid black line that passes through the center of shaded area. Times indicated are moments of mid-eclipse on the dashed lines. To convert to local time, refer to the text, *above*.

Department of Economic Developnent, State Capitol, Augusta, Maine.

THE event of July 20 will be visible, as a total or as a partial eclipse, hroughout the entire United States, xcept for Hawaii. The time of the clipse and the portion of the sun that vill be covered by the moon will vary vith locality. The approximate local time at which mid-eclipse will occur within the United States can be estimated from the map, *below,* but remember to subtract five hours from the map times for Eastern Standard Time, six hours for Central Standard Time, seven hours for Mountain Standard Time, and eight hours for Pacific Standard Time. The eclipse will begin about sixty to seventy-five minutes before the indicated time, again depending on locality, and end some sixty to seventy-five minutes after the indicated time. It will be more than 75 per cent partial — that is, more than three-fourths of the sun's diameter will be obscured — at New York, Detroit, Chicago, and Minneapolis, and progressively less at places that are situated farther south of the path of totality.



Camouflaged Still-fishing

Strange, wormlike lure draws turtle's prey

By H. Hediger

Not all animals that feed on live prey are forced to track, hunt, or overpower by superior speed, as do most carnivorous mammals, birds of prey, many reptiles, fish, and invertebrates. There are also those animals that forgo hunting and substitute patience for speed and attack. An immature tick is able to wait for months fastened to a twig, until finally an animal—a deer, perhaps, or even a toad—brushes against it. Only then does the tick fasten itself onto its host.

Large animals with a higher metabolic rate are, of course, not able to have such "patience," but even they are sometimes equipped to wait for hours, days, or weeks. They often remain motionless until, as an old German saying has it, "the fried pigeons fly into their mouths." There are two interesting aspects in this fact for the scientific observer: behavior of prey to predator, and behavior of predator to prey.

The prey-to-predator behavior—that is, the tactics of avoiding an enemy—is not haphazard and accidental. Instead, it has evolved for species preservation. Every animal species has its own escape techniques, its individual flight reaction. Further specificity may exist within this individual flight reaction. It may relate to the habits of the primary enemy (such as whether the enemy attacks from the ground or from the air) or to the type of enemy.

I discussed some aspects of animal flight in my book, *Studies of the Psychology and Behaviour of Animals in Zoos and Circuses*, and included several flight reactions as revealed, for instance, in flight distance. (As a rule, small animals run a shorter distance away from an enemy than do large animals.) In most cases, the animal's flight follows definite rules, and the distance can be measured accurately. However, before the reaction is triggered, the enemy must approach to within a specific distance from its prey.

The laws that exist in avoidance tactics of the prey also exist in the capture tactics of the predator. There are two principal types of predatory behavior among the vertebrates: active attack, which includes search, stalk, and capture; and passive approach, which consists, primarily, of lying in wait.

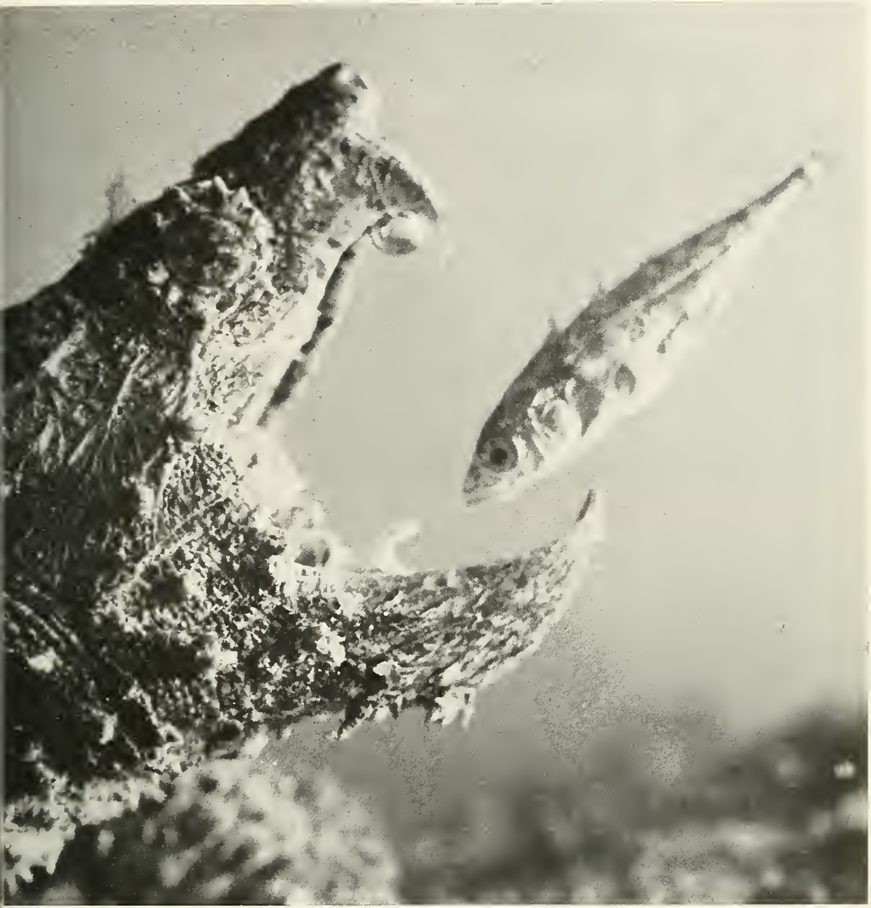
Some peculiar specializations are possible within the framework of passive capture: for example, many animals—from fish to mammals—use a "snap trap." These predators are distinguished by three characteristics: morphologically they are able to conform to the environment through camouflage; physiologically they are able to react to the prey with lightning speed; psychologically they can remain motionless for long periods at a time.

Still further differentiated are those predators that use "lure traps." These are limited to the lower vertebrates, from fish to reptile. The best-known example is the anglerfish (*Lophius piscatorius*), in which the first spine of the dorsal fin becomes a lure that is jerked back and forth in front of the large mouth and bears a strong resemblance to a small fish. Similar organs exist in other species.

In some snakes—certain vipers, moccasins, and the juvenile copperhead—the lure is a strikingly colored and moving tail tip. A pair of mobile appendages on the snout of an aquatic snake (*Herpeton*) of the Indo-Chinese region, may serve the same function.

All of these lures are located outside the mouth, but the fresh-water alligator snapping turtle (*Macroclemys temmincki*), seen on these pages, is distinguished by a lure that functions *inside* the mouth and attracts the prey directly into the trap. As far as we know, thi is unique and constitutes the best lur trap in the animal kingdom.

But before discussing the lure fur ther, let us look at *Macroclemy* itself—the only living species in th genus. This largest of all fresh-wate turtles ranges through central Illinois southern Indiana, lower Missouri southeastern Kansas, and south to th Gulf of Mexico. It is also found in east ern Oklahoma and central Texas. Usu



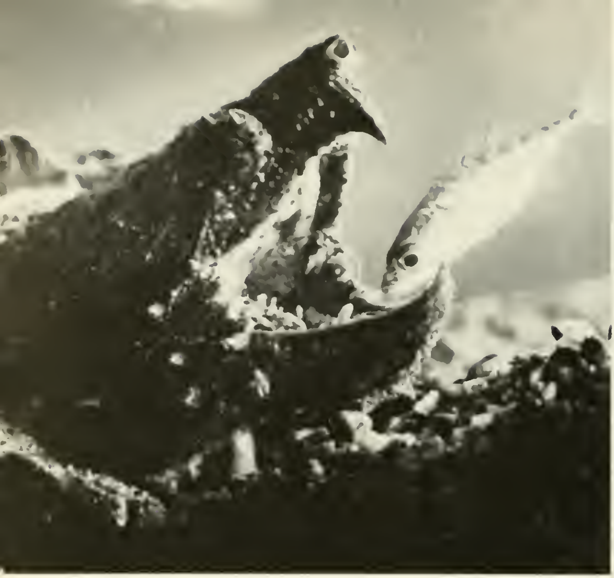
Stickleback *(Gasterosteus)* **moves to the pinkish, vermiform organ projecting from tongue of alligator turtle. When it is not in motion, lure is pale gray.**

ally two hundred pounds is thought to be its top weight. but one has been reported at over four hundred pounds. The broad. oblong, unmarked carapace is dark brown and deeply ridged. The long tail has three rows of tubercles, and it sometimes is longer than the carapace. The head, covered by plates above. is large and pointed, and the upper jaw forms a hooked beak. The eyes are set on the sides of the head and are barely visible from above.

The female, which may be somewhat larger than the male, uses her hind legs to dig her nest in soft ground. There she deposits her eggs, scrapes the dirt or sand back into the hole, and crawls over the spot to smooth it.

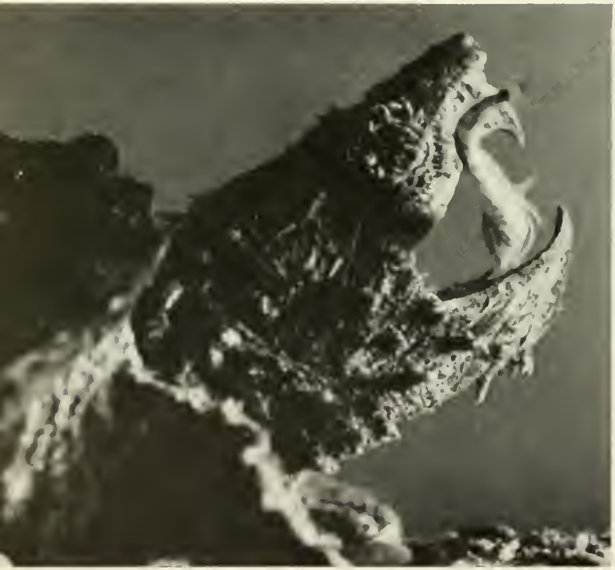
Alligator snapping turtles live in rivers, canals. lagoons and bayous, marshy lakes, and swamps, usually not far from running water. They prefer muddy bottoms. where the thick, aquatic vegetation helps to conceal them.

In the area of camouflage, this turtle is astonishing, particularly when covered by fresh-water algae. Then it takes on the appearance of a long-submerged rock; then, too, the lure mechanism is even more effective. This carnivore, which apparently prefers fish. but which undoubtedly also eats waterfowl and small mammals, has a vermiform growth on the middle of its tongue. This irregular, distensible process moves like a worm. The turtle lies on the bottom of the lake or stream, mouth agape. When at rest, the process is white or pale gray. When in motion,



it becomes pink or red, probably as a result of blood circulation. The appendage, as can be seen on these pages, has a fatal attraction for fish, which move toward it—the only moving part of the motionless turtle—until suddenly the ferocious jaws snap shut.

The herpetologist Hans Gadow was possibly the first to discover that lure mechanism. In 1909 he wrote in his book *Amphibia:* " . . . in order to attract fishes they protrude a pair of worm-like, pale pink filaments from the top of the tongue." Even though R. L. Ditmars called attention to the lure almost half a century ago, it seems to have taken a long time for anyone



Turtle remains motionless, its filamentous skin making it look like a rock. As fish reaches for the lure, the strong, toothless jaws snap shut upon it. In picture, *above*, are seen the dark eye markings that may help in camouflaging pupil.

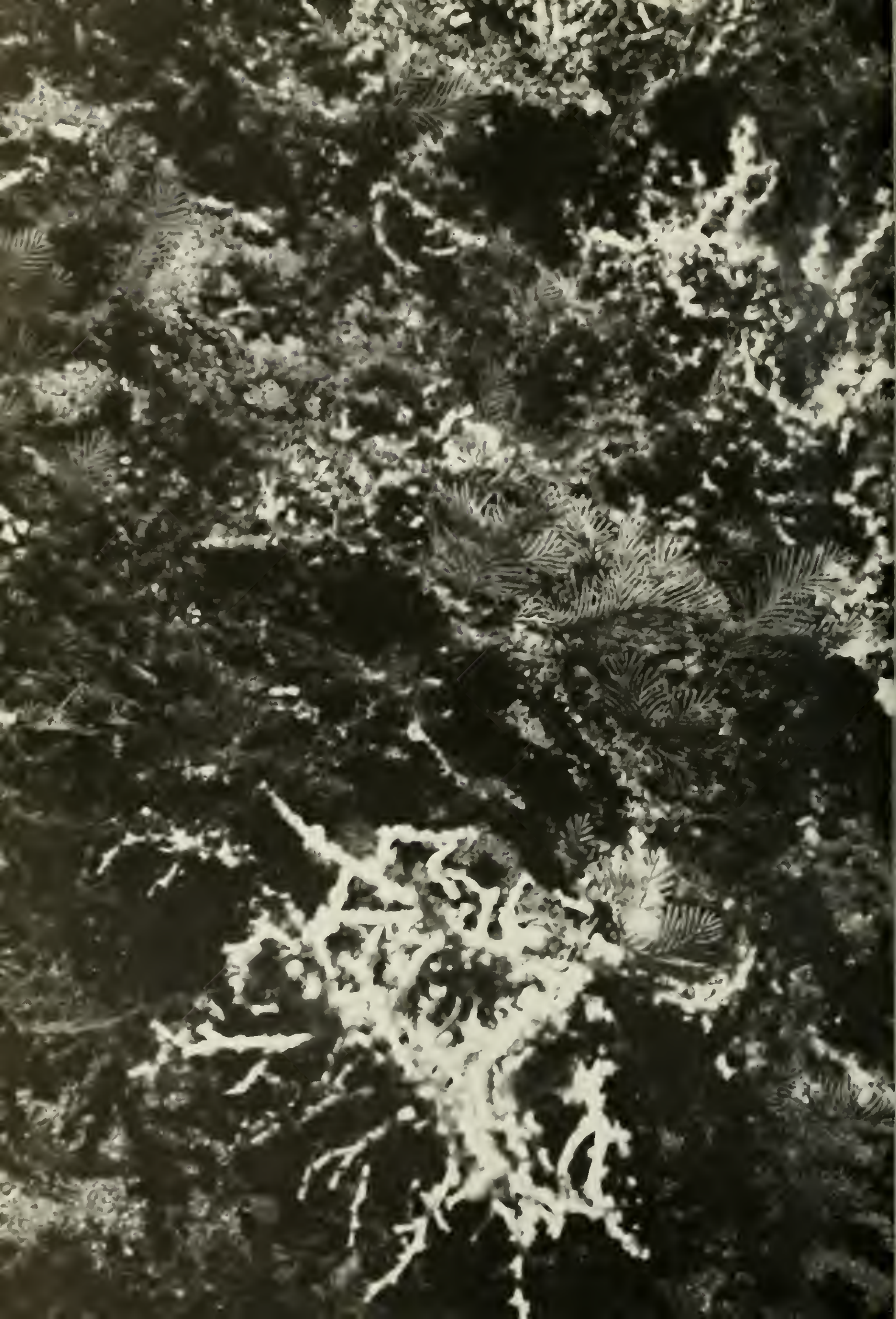
actually to observe that the lure attracts fish. Many authors who have reported the phenomenon seem to have depended solely on hearsay evidence for their descriptions.

As recently as 1939, C. H. Pope remarked that no one had succeeded in observing the total action of the lure in all its detail, and that there had been no scientific eyewitness to the manner in which a fish snaps at the decoy and thus is seized by the turtle. Many of the turtles have been kept in public aquariums. but there they were fed with dead fish, which they seize in the manner employed by other aquatic turtles. In the American literature, E. Ross Allen, Wilfred T. Neill, Archie Carr, and C. H. Pope are named as the first to watch some of the operation of the tongue appendages.

We keep several of these interesting turtles in the aquarium at the Zurich Zoo, where they regularly demonstrate the amazing action of the lure. Early in 1962 my assistants, H. Heusser and R. Honegger, were able to make both movies and still photographs of the behavior—the first time, to my knowledge, that this has been done.

The way in which *Macroclemys* uses the lure is of special interest because, as we have pointed out, the turtle is also able to catch fish in its jaws like any other aquatic turtle. Yet, it is probable that the organs were evolved to aid in food-gathering—perhaps particularly in the daytime, when the color of the process would be visible to potential prey. (The animal usually forages at night.)

The fact remains that much is still to be learned about this remarkable animal. For instance, comparatively little is known about its longevity, although one is known to have lived to well over fifty years. Its diet, too, has not been studied to any extent, nor has its over-all behavior. One thing, however, is sure. Its meat makes fine soup!



Modern Tools Probe Deep Water

Coral banks are explored seismically

By Donald F. Squires

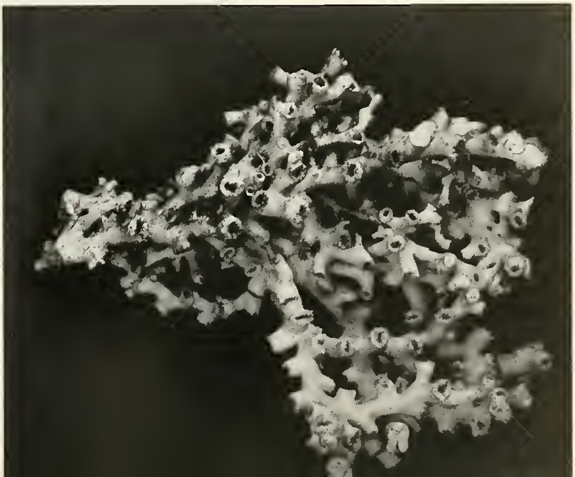
The phrase "coral reef" usually summons up images of coral ramparts besieged by foaming breakers and overhung by waving palms under brilliant blue tropical skies. While this is the setting for most coral reefs, there is a lesser known type in the cold, perpetually dark waters below the penetration of light—waters of a temperature more amenable to the cod than to the barracuda. The biological and geological potential of these coral reefs has not been assessed, but because they apparently are widely spread, they have attracted the attention of oceanographers and biologists.

Coral banks, as they are called, are found from the waters of the subarctic regions to the deeper waters of the continental shelves in the tropics, usually far beneath the depths to which even the most skilled skin diver can descend. As a result, these growths must be studied indirectly by the modern tools of an oceanographer working from a vessel a half-mile or more above the object of his attentions. Utilizing sound impulses of several frequencies and equipment including cameras, trawls, and probing cores, the oceanographer samples and records his data. From these a fascinating picture emerges.

In 1956, Drs. J. B. Hersey and S. T. Knott of Woods Hole Oceanographic Institute were aboard the *Atlantis*, making a number of geophysical traverses across the Blake Plateau, a broad expanse of flat sea bottom off the southeastern United States. About two hundred miles southeast of Charleston, South Carolina, they encountered an area of characteristic, hummocky topography, which, for lack of a better term, they called the "bump area." Because of time restrictions, they were unable to investigate intensively, but for the next five years every opportunity was taken to cross the "bumps," and thousands upon thousands of feet of echo-sounding traces of the area were accumulated.

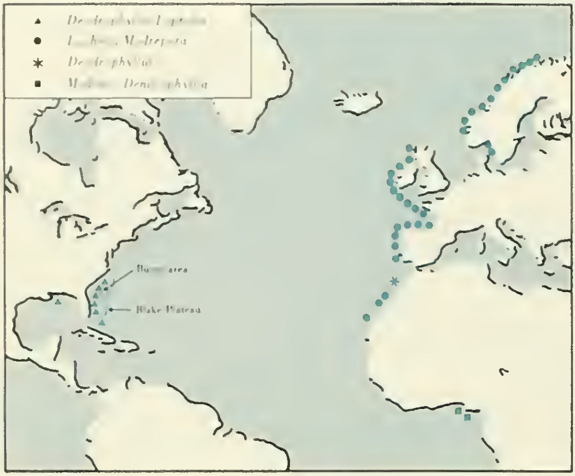
Then, in early 1961, the *Atlantis* went out with Thomas Stetson as chief scientist to undertake detailed studies. The complement of geophysical gear included precision depth recorders, seismic profiling instruments, deep-water photography equipment, grab samplers, dredges, and trawls. The Blake Plateau is not a restricted region that can be studied easily, for the bumps extend over an area greater than 1,500 square miles. There apparently are thousands of bumps; each poses a special problem, and each should be studied individually. In addition, the motion of the Gulf Stream, which flows over the bumps, makes it difficult to position the ship. As a result, cameras and dredges may be strung out at the end of a half-mile or more of wire and may sometimes drift a considerable distance beyond the immediate area to be sampled.

Before the cruise began, several hypotheses had been developed to explain the occurrence of bumps. One theory held that they represented volcanic structures or possibly remnants of volcanic cones; another that they were accumulations of coral materials, possibly analogous to a coral reef. Long before the end of the trip, it was apparent that the second hypothesis was at least partly correct, for the dredges and grab samplers brought up bushels of branched coral with each cast. It was not until much later, when



Branching *D. profunda, left,* is the most abundant coral found on Blake Plateau.

Broken skeletons of *Lophelia* form the base for deepwater coral structures.

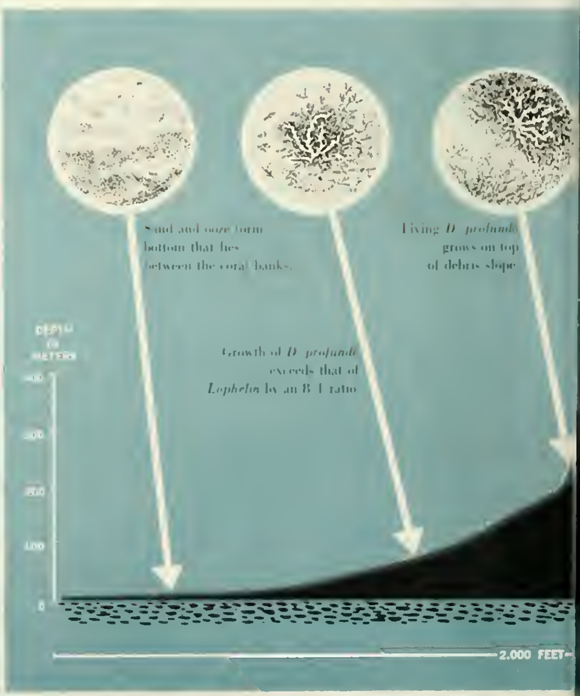

▲ Dendrophyllia-Lophelia
● Lophelia-Madrepora
✱ Dendrophyllia
■ Madrepora-Dendrophyllia
Bump area
Blake Plateau

Map shows distribution of structure-forming associations, including known banks. Line at left indicates edge of Blake Plateau, on which is bump area.

the results of the seismic profiling and topographic echo soundings had been studied in detail, that there was a distinct possibility that the first hypothesis might also be correct.

As a result of many crossings of the bump area by the *Atlantis* and of searches of earlier echo-sounding records and surveys of museum collections of corals, we now have some concept of the distribution of coral structures on the Blake Plateau. Because these structures are now known to be composed of coral, at least superficially, the word bump, adopted only as a loose descriptive term, can be abandoned in favor of the more precise word "bank." Although bank was originally coined to cover all types of coral structures occurring in deep water, it is now restricted to more advanced stages of development of these features, such as those found on the Blake Plateau. We are not sure, however, whether they are several long, possibly continuous, ridges or a series of discrete banks, possibly coalescing laterally as they grow. The banks are aligned approximately north and south along certain geologic features and seem to be related to currents in their distribution. From the remarkable photographs taken by Richard M. Pratt with Professor Harold Edgerton's cameras, we know a great deal about the appearance of the banks and have learned something about the way in which they are constructed internally.

The coral banks on the Blake Plateau are formed principally by two species of coral. One, *Lophelia prolifera*, is found on other Atlantic coral banks. Other corals are more abundant, but the strong skeleton of *Lophelia* makes it the primary framework growth. Both *Lophelia* and the second species, *Dendrophyllia profunda*, resemble trees in their mode of branching. *Lophelia*, like an elm, grows with steeply inclined branches, many of which fuse together. As the branches become smaller at the tips they cross and intermingle, and the invertebrate animals (called polyps) that form the skeleton secrete calcium carbonate and weld the branches into a strong unit. When the polyps die, the skeleton collapses and breaks into relatively large fragments that accumulate like branches in a pile of leaves. They hold together the mass that is formed from a variety

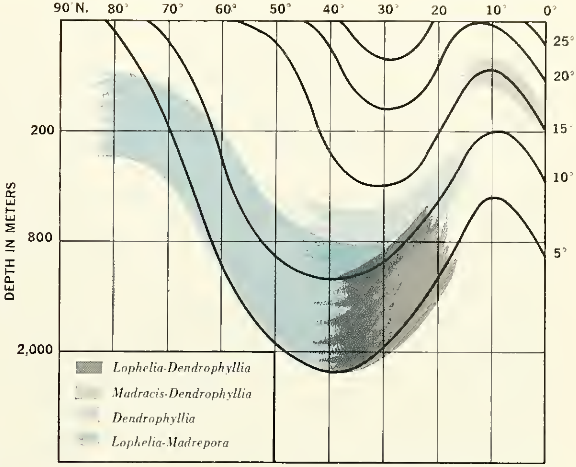

Sand and ooze form bottom that lies between the coral banks.
Living D. profunda grows on top of debris slope
DEPTH IN METERS
400
300
200
100
0
Growth of D. profunda exceeds that of Lophelia by an 8:1 ratio
2,000 FEET

of skeletal material of other organisms iving on and around the coral.

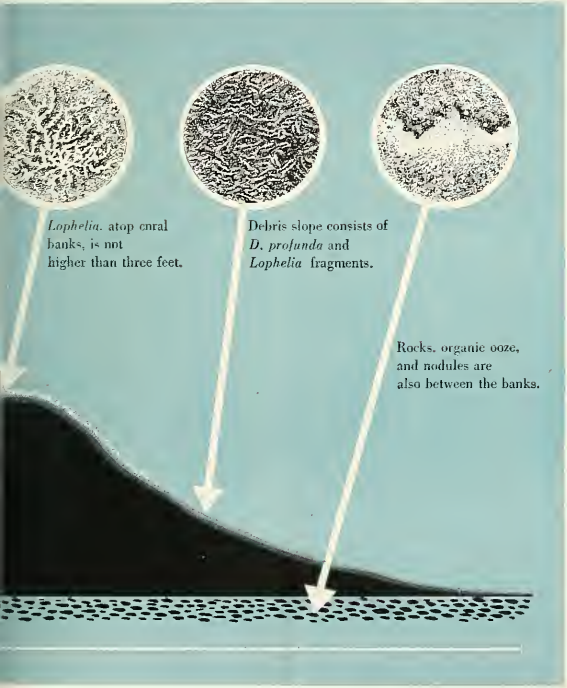
THE most abundant coral of the Blake Plateau banks, *Dendrophylia,* branches in a more random manner, making large, bushy colonies. The polyps forming the skeleton of this pecies do not secrete a solid mass, but nake a porous structure, the branches f which are free and not fused. As a esult, the skeleton is not nearly as trong as that of *Lophelia,* and after he death of the coral animal. the calareous structure tends to become roken into pieces three or four inches ong. These accumulate rapidly and re further broken up by other oranisms that live on the bank, resulting in a tangled but porous mass, with he interstices still open.

In areas of coral bank development n the Blake Plateau, bottom currents pparently transport quantities of calareous mud particles that become rapped in the matrix formed by the coral fragments. Through this mechanism the bank becomes dense and solid.

Associated with the two main species of coral are three little horn. or cup, corals, *Caryophyllia, Thecopsammia,* and *Dasmosmilia.* More kinds will probably be located as studies are continued on the faunas collected, but it is now known that these two are relatively uncommon on the banks. However, samples taken between banks have shown them to be present in the area in considerable numbers, while the bank-forming types are rare or absent. The little corals require rock surfaces or shell fragments on which to secrete their initial skeletons, and they settle upon dead coral fragments on the bank. Between banks they usually settle on the rock basement, which is exposed in the area. *Lophelia* and *Dendrophyllia* also begin life on some hard object, but apparently once they are established and have grown to maturity, most of their proliferation occurs as branches break off from the larger colonies. These may either die or continue to grow and form other colonies. We do not know what causes breakage of the colonies, but there is some reason to believe that fish may be contributing factors. Smaller fish might well attempt to take refuge in the "thickets" of coral, but unlike their terrestrial counterparts, the thickets have branches that will not bend as the

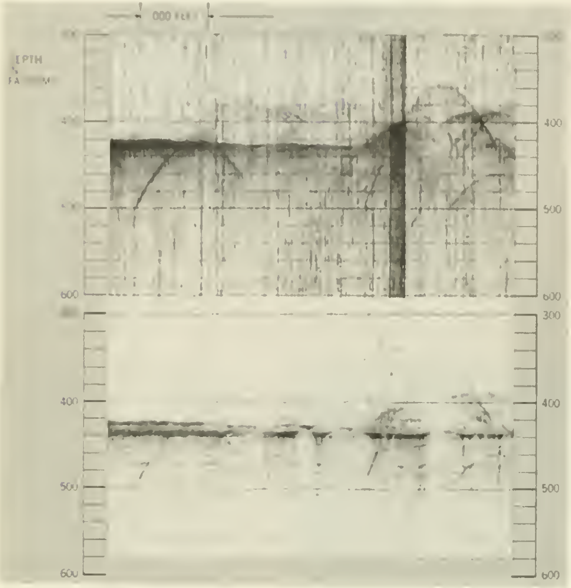


ISOTHERMS (lines joining points with the same mean temperature for a given period) are for generalized section of east and west coasts of North Atlantic.

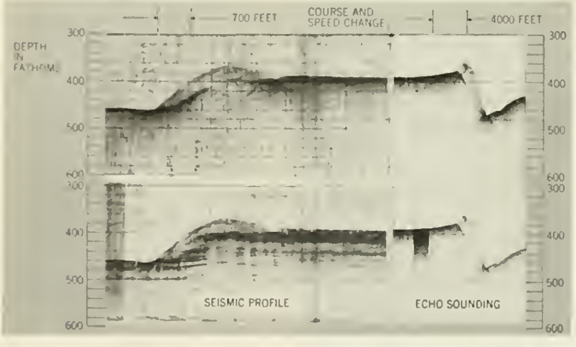

Lophelia. atop coral banks, is not higher than three feet.
Debris slope consists of *D. profunda* and *Lophelia* fragments.
Rocks. organic ooze, and nodules are also between the banks.

animal brushes against them while seeking cover, and large pieces of coral may be broken off.

Numbers of other animals live on the coral banks. Photographs show octopuses, sea urchins, brittle stars, sea anemones, sea fans, and large sponges, and future studies will undoubtedly lengthen the list. However, it is curious that very few mollusks are found in either the photographs or the collections. Clams and snails are always an appreciable part of the fauna of the shallow-water reefs, where they are usually hidden during the day, coming out at night to feed. Because there is perpetual night on the coral banks, there should be no reason for the animals to be in hiding diurnall



CONTINUOUS seismic profile, part of which is shown above, revealed strong subbottom, reflecting the horizons that underlie structure of the coral banks.



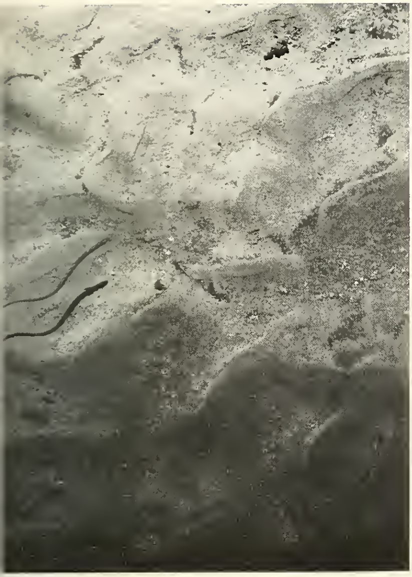
PART of seismic profile is compared with echo soundings over similar areas. Difference in horizontal scale results from differences in speed of the ship.

Deepwater coral banks have bee known for over a hundred years. The were first discovered off the coast Norway, in depths ranging from fort or fifty feet to three hundred or fou hundred feet. Because they were goo fishing grounds, and because the net of the fishermen were torn to shred when they became entangled in th corals, the banks were the subjects o early investigation, and many hundreds of them were mapped by th turn of the century.

THE Service Hydrographique Marine et Office Scientifique et Technique des Pêches Maritimes, o France, was the next to study th French deepwater banks, and map showing the positions of several thousand more were printed in 1921. It wa then seen that the coral banks o France were in deeper water than thos off the coast of Norway, that the northern Norwegian banks were dying, an that some of glacial age had recentl been uplifted. At the time these fact became known, the main interest wa to determine the position, extent, an numbers of the banks, and with goo reason; it is recorded that unwar fishermen might bring up five or si tons of coral in their deep net casts.

It was also found that the Europea banks are formed by two or thre types of coral—bushy and branchin forms such as *Lophelia, Madrepor* and *Dendrophyllia.* Other small corals are present, but do not contribute particularly to the structure the bank. Plants, of course, are abse on the deeper banks, but many organisms are found only on the bank and not in the areas between, and a many as three hundred species hav been catalogued from the Scandinavian banks alone. Some of the bank are large—up to a mile in diameter an several hundred feet thick—and ar usually located in areas of strong currents of water, such as in the mouth of fiords or along the edge of the continental shelf.

Although the effect has not bee measured, it has been suggested tha the banks along the edge of the European continental shelf, from the Porcupine Bank, off England, to the coas of Spain, are oriented in relation t upwelling of water along the face o the slope. If the coral banks are related to currents wherever they occur it is a requirement in common wit



IPPLED SAND and ooze are characteristic of the bottom etween the banks. An absence of coral debris is notable.

ROCK-OUTCROPPING between banks is in background, organic ooze in the foreground. White spots are probably cup corals.

nalogous shallow-water reefs, for the opical reef corals prosper in the rashing force of the great ocean wells. As mentioned before, the banks n the Blake Plateau seem to be strung ut in long lines extending approxi- ately north and south. Collections ade on the Plateau to the south of e area studied by the *Atlantis* indi- ate that the banks may extend south- ard roughly along the line of the ur hundred fathoms contour—per- aps along the path of some as yet nknown and unmeasured current.

The temperature requirements of ank corals are also being studied. It s known that tropical reef corals grow est at a temperature of about 25° to 9° C. They can also grow in temper- tures as low as 18° C., but do not de- elop well; below that temperature nly isolated patches occur.

Deepwater coral structures flour- sh in much colder waters than shal- w-water reefs, but exhibit a very ide range of temperature prefer- nces. At least four different suites of oral are known to participate in the ormation of deepwater coral struc- ures in the North Atlantic Ocean, ach of which has its own preferred temperatures for optimal development. Some, such as the *Madracis–Dendrophyllia* assemblage, found in structures on the Niger Delta, prefer temperatures of the order of 15° to 20° C. The *Lophelia–Madrepora* assemblage, characteristic of the Scandinavian coral structures, is found only in waters having a temperature range of 4° to 12° C. The *Lophelia–Dendrophyllia* fauna of the Blake Plateau and other western North Atlantic occurrences appears to prefer a temperature range of 7° to 10° C. All these data indicate one common feature—occurrence below the thermocline. Surface waters of the ocean fluctuate greatly in temperature with the changing of seasons and courses of currents. With increasing depth of water, however, stabilization of temperature occurs. It is at the depth at which waters are cool throughout the year and have a very small, stable temperature range that the thermocline occurs. No deepwater coral structures are known to live above the thermocline, regardless of the temperature above or below.

One of the most dramatic examples of this restriction in occurrence is shown in the coral banks of Scandinavia. Because of the cool waters there, coral banks live and flourish in relatively shallow water, where the thermocline is at depths of about 100 to 150 meters. As the Scandinavian peninsula rises in response to the melting ice from the great Pleistocene glaciation, these coral structures are brought into progressively shallower waters. Some have actually been uplifted from the sea and are known as subfossil banks. Others have been uplifted dangerously close to the thermocline. Recent studies of the North Brattholmen coral bank, by Drs. Cyril Burdon-Jones and Hans Tambs-Lyche, have shown that the upper portion of this bank is composed only of dead coral and that the living coral is restricted to a ring around the bank at depths greater than 100 meters, which is the depth of the thermocline.

To the south, the coral banks of each faunal type follow their preferred temperatures downward along the thermal gradient. The *Lophelia–Madrepora* banks of relatively shallow water in Scandinavia are found at depths of many hundreds of fathoms off France, where there are waters that

are in the same range of temperatur
One of many questions raised
the recent studies of coral banks
that of how they begin. A logical s
quence of events can be postulate
Undoubtedly, the bank begins with
single coral. If the planula larva
for example, *Lophelia prolifera* we
to settle in an area favorable to i
type, it would begin to grow well a
rapidly on a solid surface, such as pr
vided by a clamshell. Soon the sma
coral would develop into an arbore
cent colony and would begin to modi
the environment in which it was gro
ing. This early modification would
subtle, even ephemeral. For instan
fish might seek shelter among t
branches. When the fish swim throu
the colony, branches might be brok
off, and as these branches lie on t
bottom they might continue growi
into new colonies. The dead branch
of the coral furnish a hard substra
for larvae produced by the matu
colony to settle upon and begin grow

As this process continues, we
longer have a single colony, b
rather, a number of colonies formi
a thicket. While the thicket grow
many changes take place. The cora
offer increasing amounts of shelt
support, and food for other anima
particularly invertebrates. Each n
coral animal modifies the environme
and makes room for yet other anima
The broken branches of coral accum
late around the thicket, and mud
gins to be entrapped in the spac
between the branches. This mud b
tom is an added dimension to the
vironment—one not found elsewhe
on the Blake Plateau in waters
similar depths. Whole hosts of n
adult organisms and larvae can no
move onto the bank, for that is wh
the group of colonies has become.
the microscopic, submicroscopic, a
larger animals that live in the mud a
feed upon each other permit an ev
wider development of the bank faun
It is, then, quite probable that
coral bank begins in a very mode
way, but gradually and subtly chang
its immediate environment. Of cours
there must be controls, for not eve
colony grows to be a thicket or a ban
The controlling factors probably a
a complex of delicate balances betwe
such elements as temperature, curren

Debris slope is largely of *D. profun*
fragments. Octopus is at bottom righ

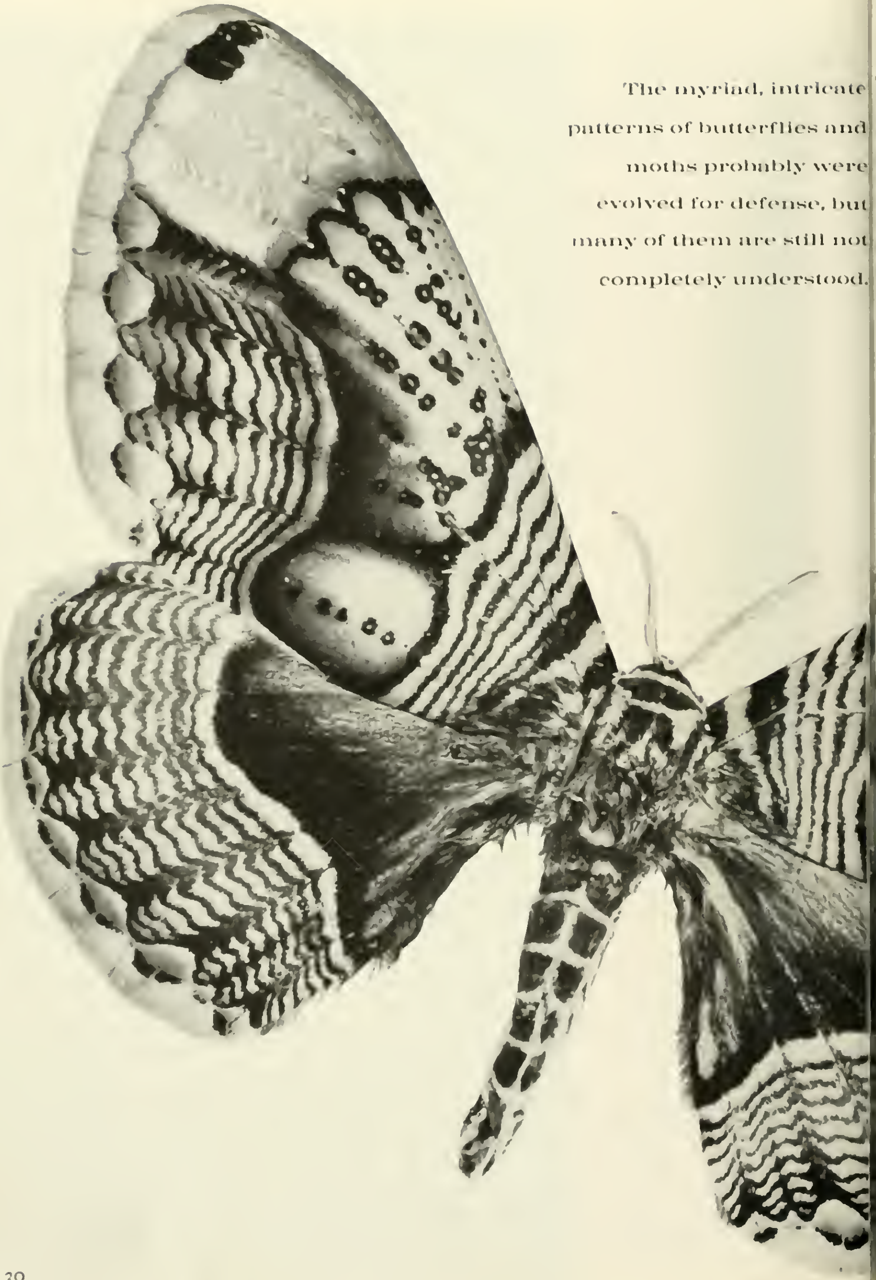
ood. suspended sediment, and other onditions that are less well defined.

Returning to the earlier comparison f coral reefs and coral banks, the nost striking feature of the tropical oral reef is the great diversity of life t supports. Teeming with fish and haroring myriads of corals, sea fans, nemones, crustaceans, mollusks, orms, echinoderms, and many other reatures, the coral reef is a spectaclar assemblage. In some areas, isoated local reefs, called patch reefs, nay develop. These are particularly emarkable on the Bahama banks here individual patch reefs, twenty o fifty feet in diameter, may be sepaated by several miles of barren oölitic and where none of the larger forms f life is seen, aside from an odd hark or other open-water fish or an ccasional wandering conch. Arising uddenly from the bottom is a nearly ircular patch reef that grows up to he low-water level. A full array of orals is present, but even more strikng is the vast number of other inverebrates and many of the smaller "reef ish." These animals, congregated in n oasis on a biological desert, are resent in response to the reef's environmental complex. Many are present olely because of the protective charcteristics of the reef.

It is in the diversity and multiplicity f ecological niches formed by a coral ommunity that the greatest similarity etween tropical reefs and coral banks an be seen. Coral growth, no matter vhat the type, usually results in the ormation of an irregular rocky mass erforated by numerous holes, nooks, nd crannies. In these the more timid nembers of the fauna can find shelter, nd the night feeders can hide throughut the day. Hard surfaces upon which arvae can attach are available. inally, the coral rock furnishes the ard, but not too hard, substrate eeded by the boring animals.

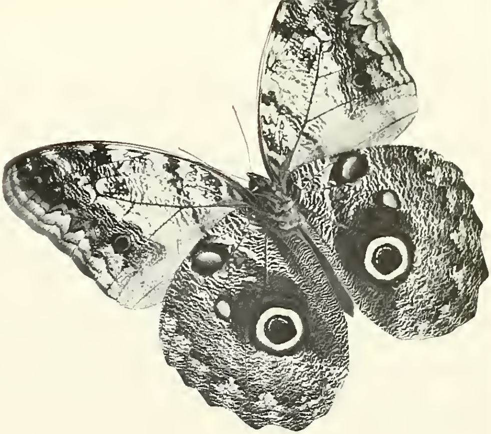
WHILE this article was being written, the *Atlantis* was getting eady to sail again to the coral banks o continue the many-faceted investigations. Now that such banks are nown to occur in numbers close to the hores of this country, they can be ntensively studied, and perhaps will ne day be as well understood as their hallow-water tropical counterparts.

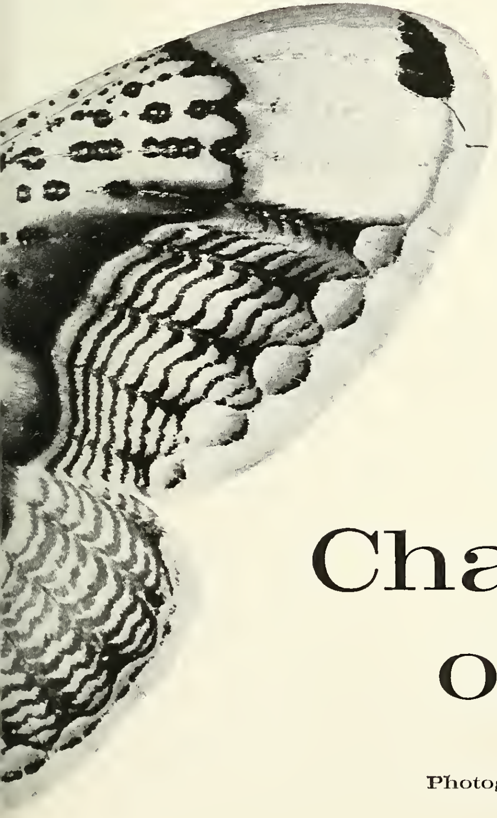
ARIOUS COELENTERATES grow on debris lope of this bank in Blake Plateau.



The myriad, intricate patterns of butterflies and moths probably were evolved for defense, but many of them are still not completely understood.

The magnificent insect, *below,* is *Brahmaea wallichii,* which is found in Assam. It has a highly disruptive pattern of rich brown and cream color, plus two prominent eyespots. *Caligo prometheus,* one of the large Owl butterflies of the New World, *right,* carries two enormous and startling eyespots on what is otherwise a cryptic pattern.





On the Character of Color

By ALEXANDER B. KLOTS

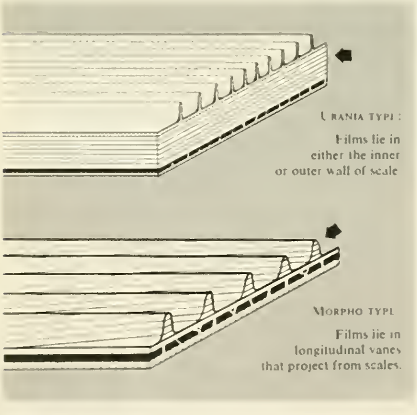
Photographs by KJELL B. SANDVED

The butterflies and moths, which comprise the insect order Lepidoptera, number perhaps 100,000 species. More than any other group of animals they have evolved a complexity of color and pattern that presents an almost infinite variety of beauty and interest. Only the birds, in fact, can compare with them in this respect, and even they show less variety.

The colors of butterflies and moths (and of birds, too) are of two types pigmental and structural. A pigment is a chemically specific substance that, by absorbing certain wave lengths of incident light and transmitting only the remainder appears to have a certain color — that of the transmitted wave lengths. The pigment merely screens out some colors, and does not change the wave lengths of those it transmits.

Structural colors, on the other hand, are not determined by the chemical nature of the color-causing substance, but by its physical structure. There are no blue pigments in the sky, in cigar smoke, in blue eyes, in the feathers of blue jays, or in the scales of a *Morpho* butterfly; instead, there are minute structures that, by purely physical means, actually change the wave lengths of the incident light into the wave lengths they emit. Because these are in the blue end of the spectrum, they "look blue." The color-causing substance may be, and in fact usually is, colorless pigmentally.

Since pigments are specific substances, they can be dissolved out with the proper solvent, or changed by means of a chemical reaction. Their colors are not affected by purely physical means, such as pressure, swelling, or shrinking, which have very drastic effects when applied to the exceedingly minute color-causing structures. Pigmented surfaces or substances will look darker if wetted, but no change in hue will occur. Structural color, on the other hand, will be totally destroyed if the color-causing system is wetted or permeated with a liquid of the sam index of refraction, but will be restored unchanged this liquid is removed. As noted, pigments absorb, an never transmit, some of the components of the inciden light. With structural color, on the other hand, all of th components of the incident light can be accounted fo in the reflected, transmitted, or scattered light.



Two main types of color-forming films are found on Lepidoptera scales

The source of most butterfly and moth colors is th scales, which usually cover the wings thickly. As th wings develop in the pupa, each scale is formed by single cell as a flattened, hollow sac, composed chiefl of chitin — the characteristic tough, flexible substanc of the insect exoskeleton. Thus, it is a very simple matte for a scale to be built up in a series of layers which, a we shall see, are responsible for structural colors. Pro jecting from the outer surface of the scale are usuall many fine, more or less parallel ribs, or vanes, wit grooves between them. Layers of pigment may also b formed, ordinarily as a lining of a scale wall.

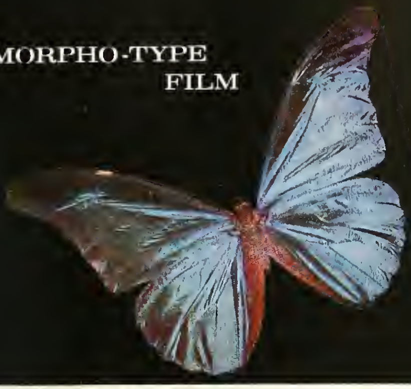
Butterflies and moths form many pigments, of whic the commonest types are the melanins (reds to browns t blacks), the carotenoids and flavones derived from plan (chiefly reds, oranges, yellows, and greens), and the uri acid-derived pterins of the Sulphur butterflies (yellows t oranges, reds, and browns). Pigmental greens occur i a few adult moths, but probably in no butterflies, althoug a semblance of green is caused by mixtures of finel divided black and yellow pigments. Many caterpillars ar green, chiefly owing to the chlorophylls or chlorophyl like pigments of their plant foods.

White pigments, strictly speaking, do not occur, fo white is not a color and cannot be caused by pigment action. The appearance of white — whether of snow New England churches, doves of peace, or Cabbag butterflies—is a structural effect caused by an efficien scattering, by physical means, of incident white ligh

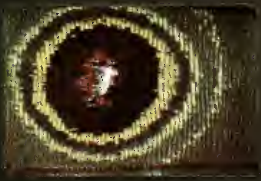
Such phenomena as luster and iridescence also ar caused physically. Lusters range from matte throug velvety and satiny to highly specular, or mirror-like, an metallic. In butterflies and moths they are caused b the scattering, to a greater or lesser degree, of transmi ted light, chiefly by overlapping, transparent scales. Man degrees of luster occur, often in combination with pig mental or structural colors, producing an enormou variety of effects. The brilliant, silvery spots on the wing of many of our Fritillary butterflies *(Argynnis, Speyeri* and *Dione)* represent pure luster with little or no pig mental effect. Some of the world-wide Copper butterflie *(Lycaena)* have a bright, metallic luster and a copper red pigment; other Coppers also have a fugitive blue o purple iridescence caused by internal scale structures.

Iridescence involves a special type of structural colo production, often of a number of colors, each at a differ ent angle of the incident light, and each transmitted at different angle. Thus, at a certain angle of the inciden light a structural purple will be transmitted; as the angl becomes more acute, the color transmitted will change t red, and through that to orange, yellow, and green. Sud denly, as a certain very acute angle is exceeded, no colo or light at all will be transmitted. Since butterfly and mot

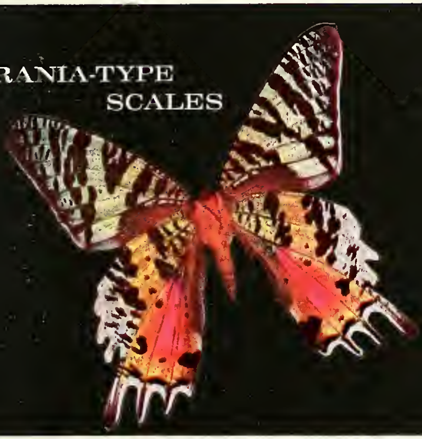
MORPHO-TYPE FILM



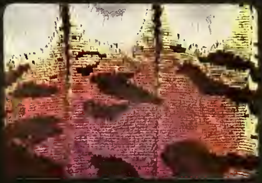
Film intensifies blues of *Morpho rhetenor* (French Guiana) and covers underlying brown pigments. Contrasting eyespot is on wing's underside.



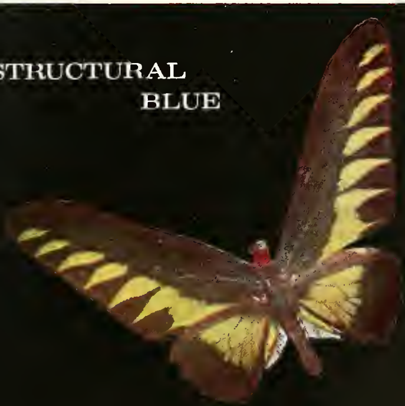
URANIA-TYPE SCALES



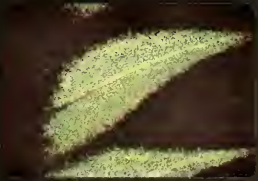
Iridescence of scales of *Chrysiridia madagascariensis*, a day-flying Uranid moth from Madagascar, overlies a wide range of wing colors.

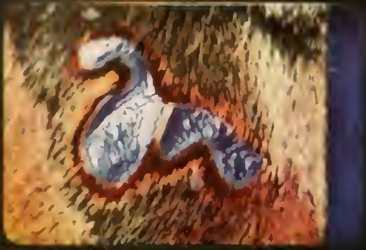


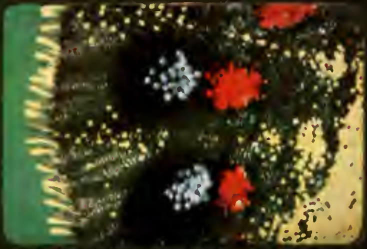
STRUCTURAL BLUE

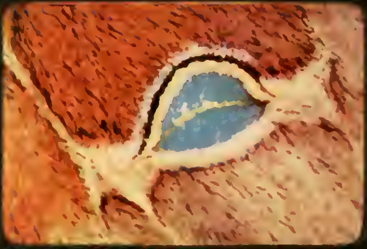


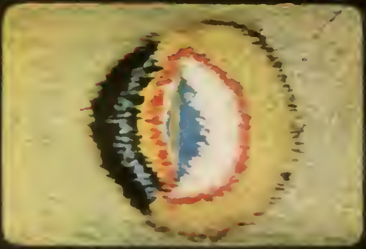
Blue combines with pigmental yellow in some males, as in *Battus brookianus* of Borneo, to form bright bands of a clear, velvety green.




Saturniidae: *Holocera agomensis* (Rhodesia)

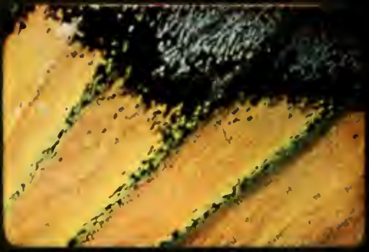

Papilionidae: *Archon apollinus* (Syria)

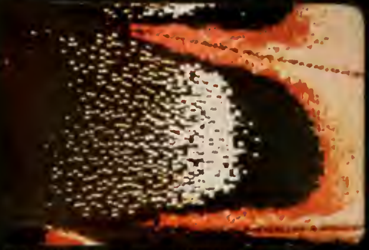

Saturniidae: *Antheraea polyphemus* (U.S.A.)

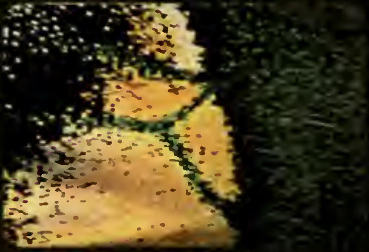

Saturniidae: *Actias luna* (U.S.A.)

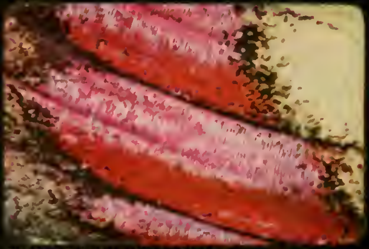
Eyespots, such as those pictured above, may have remarkably "startling" effects when they are exposed or moved suddenly. Thus, the reflexes of predators may be interrupted, allowing the moth or butterfly to escape.

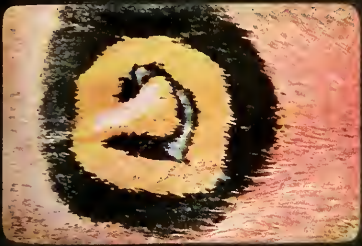
Brightly colored, iridescent markings often have a highly disruptive function, serving to confuse or distract an attacker. This "technique" is one of the main components of man-made camouflage methods.


Papilionidae: *Teinopalpus imperialis* (China)

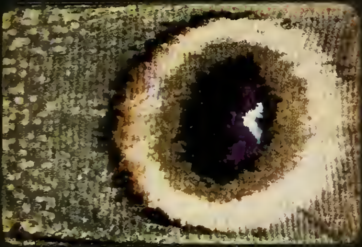

Papilionidae: *Papilio garamas* (Mexico)


Papilionidae: *Teinopalpus imperialis* (Sikkim)

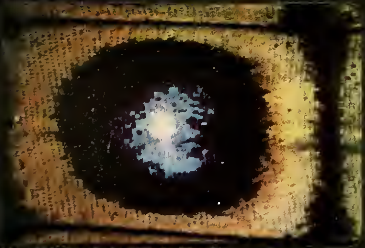

Pieridae: *Colotis ione* (East Africa)



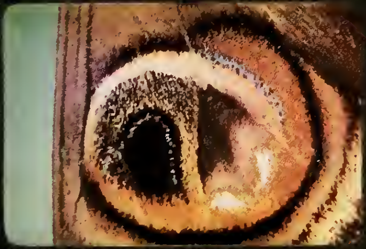
Saturniidae: *Ludia delagorguei* (Nyassaland)



Nymphalidae: *Prepona omphale* (Peru)



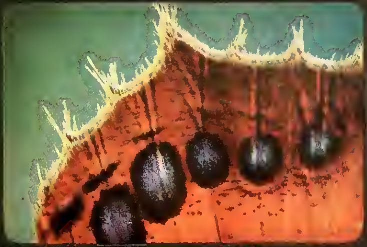
Nymphalidae: *Agrias claudia* (Brazil)



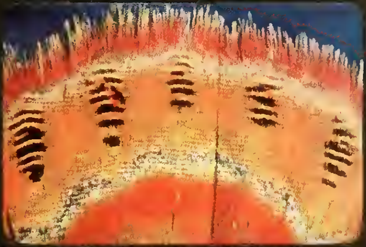
Noctuidae: *Cyligramma latona* (Kenya)

Eyespots occur in myriad variations on the wings of butterflies and moths. No other markings so instantaneously rivet the attention, and they may be of considerable importance in the survival of a species.

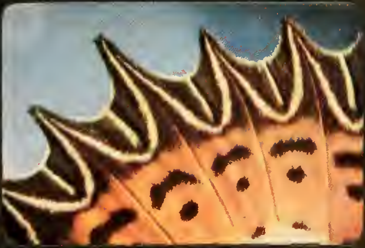
Another aspect of defense is in conspicuous wing-edge markings, such as those below. These often divert attacks of a predator to an area where little harm is done, and where only the partial loss of a wing margin results.



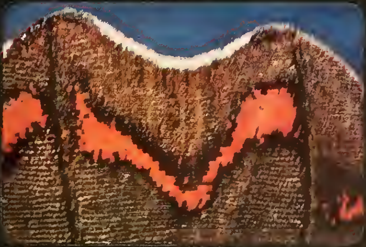
Nymphalidae: *Charaxes pelius* (Nyassaland)



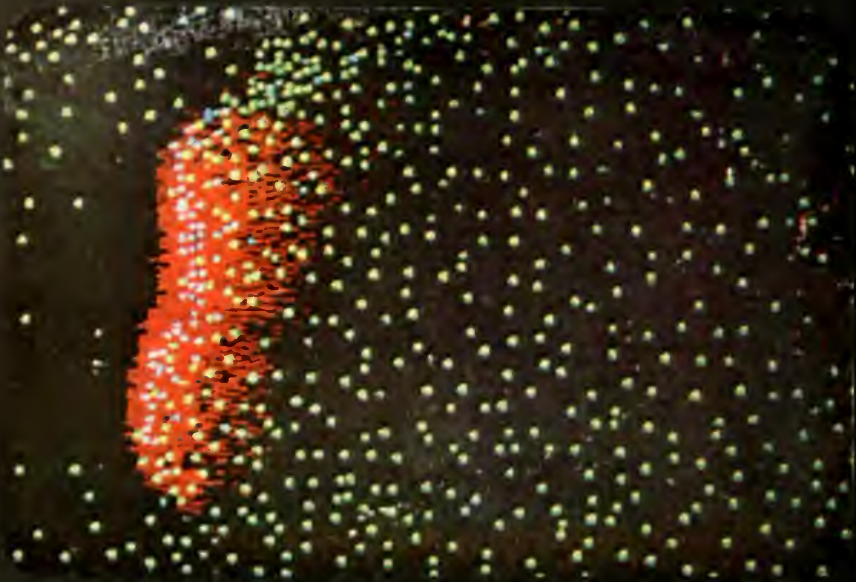
Geometridae: *Uranedexa longicornis* (Guadalcanal)



Nymphalidae: *Cethosia biblis* (Thailand)

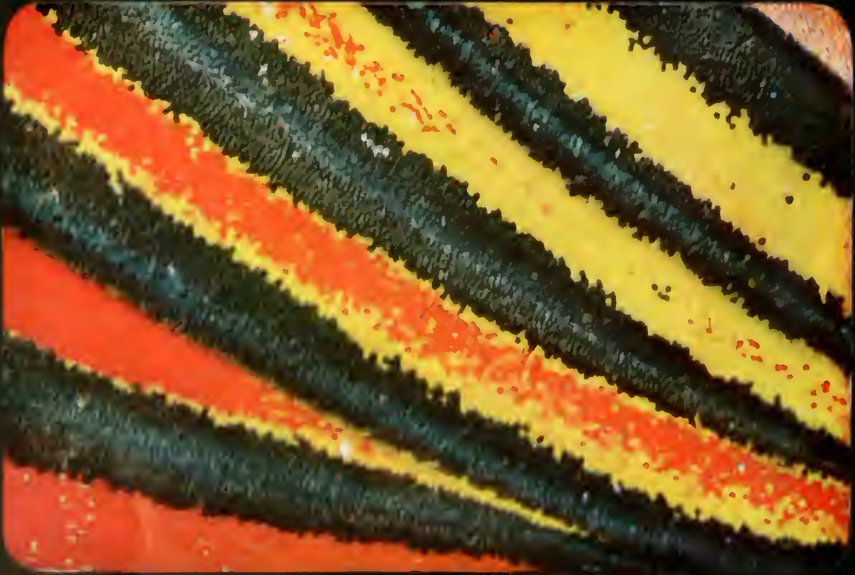


Papilionidae: *Battus laodamus* (Mexico)



Papilionidae: *Papilio krishna* (Sikkim)

Zygaenidae: *Campylotes histrionicus* (China)



scales are exceedingly small and packed closely together, and are not plane, but curved, the color bands that each transmits will overlap — and be overlapped by — the color bands of its neighbors. The eye, unable to resolve the fine details of the individual color bands, or even of most individual scales, will receive simultaneous impressions of a number of colors. These will shift and merge into each other with every minute change of the angles of the incident light or of vision. The sequences of structural colors that result from such progressive changes of the angles of light were first studied by Newton, and are known as Newton's Series. They are widely used in spectroscopic analysis, particularly in petrography and crystallography. They are invaluable in studying the structural colors of many life forms.

The physicist recognizes a number of ways in which structural colors are produced, only three of which need concern us as part of the living world. These are: finely divided particles, producing Tyndall blue; diffraction gratings, producing many colors; and thin laminae, or films, also producing many colors.

Tyndall blue is produced when white light is passed through a medium of one index of refraction that contains finely divided particles with a different refraction index. The blue of the sky is caused by particles of water vapor, extremely fine dust and other impurities, and air molecules of the proper diameters to scatter the blue wave lengths. As the particles become larger, the blue becomes whitish; finally, scattering results in the white of clouds. The blues of smoke, blue eyes, skim milk and similar liquids are common examples of the same thing. Some insects, such as dragonflies (but no butterflies and moths), show Tyndall blues. So do many non-iridescent blue birds, such as jays, parrots, and macaws, in which the cause is a multiplicity of minute, air-filled pores in the outer layer of the feather barbs. The iridescent colors for which so many birds are noted are caused, as in butterflies and moths, by thin films. These are formed layer by layer in the barbules of the developing feathers.

Diffraction gratings are formed by a series of extremely fine, parallel grooves, or ribs, on a surface. They give color spectra that may be brilliant when the incident light is polarized or essentially unidirectional, but show no color in thoroughly diffuse light. In life, diffraction gratings are apparently very rare, being at best only weakly visible in one group of beetles *(Serica)*. Perhaps the striations and ribs of some butterfly and moth scales form diffraction gratings of a sort, but their effect is negligible.

We are left, then, with thin laminae, or films, as the remaining possibility for the origin of the structural and iridescent colors of butterflies and moths. Lying in the scales, these are extremely thin, ranging from 1.5 microns (a micron is about one twenty-five thousandth of an inch) down to as little as 0.3 micron. We have all seen thin film colors in soap bubbles and oil films on water or (better yet) on wet asphalt. Their origin is accounted for by the layer-by-layer formation of each scale. The thickness of the film or films directly affects the color or colors produced (in the sequences of Newton's Series), as well as the angle at which each color is refracted. The presence of pigments and thin films will, of course, modify the color effect, sometimes very strongly. In some *Colotis*, for example *(p. 34)*, the forewings have bright, orange-red tips caused by pigment and a structural blue; the result is a lovely iridescent purple. Curiously, many other closely related species have orange but lack structural blue. In the brilliantly blue Morphos of the American tropics *(p. 33, top)* an underlying layer of black or deep brown pigment greatly intensifies the effect of the structural blue caused by thin films. And in the great Bird-winged butterflies, such as *Battus brookianus (p. 33, bottom)* of Indo-Australia, structural blue combines, in the males of some species, with a yellow pigmental color to form a velvety green.

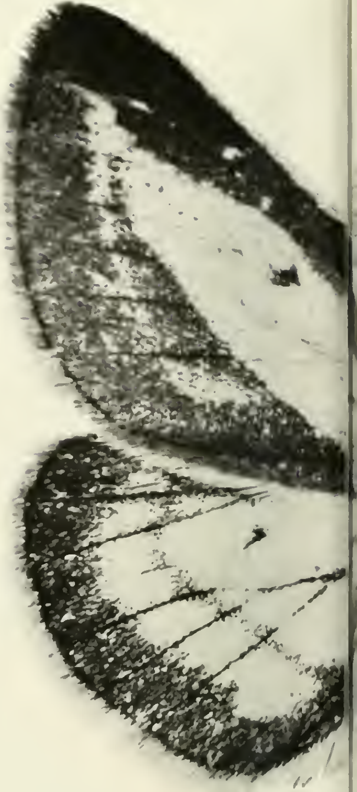
Two chief types of thin film scales are recognized. In the *Morpho* type *(p. 32, lower drawing)*, the color-forming films lie in the narrow, longitudinal ribs, or vanes, which project from the outer surface of each scale. The films are not parallel to the plane of the scale and vanes, but slant downward toward the base of the scale at an angle of 10-20°. In such species as *Morpho rhetenor (p. 33, top)* the blue is extremely specular, or mirror-like. In some butterflies with this type of scale, such as the long-tailed *Ancyluris* of the Metalmark family, the blue is visible only within a rather narrow angular range. Some temperate zone butterflies have such scales, the European Purple Emperor, *Apatura iris*, being one.

The brilliance of the blue of several of the Morphos is all the more marked when they are flying, for the lower surfaces of their wings are relatively dark, and the blue is seen only in flashes as the wings beat up and down. Normally these Morphos fly high. Once, flying at least five hundred feet above the forest canopy, I was able to see flashes of brilliant blue light that I feel sure were *M. rhetenor* flying just above the foliage.

In the *Urania* type of scale *(p. 32, upper drawing)* the thin films lie in the body of the scale, in either the upper (outer) or lower (inner) wall, not in the projecting vanes. The colors and iridescence are often affected strongly by the overlying vanes or bosses, and by overlying pigment layers. Iridescence may cover a wide range of colors, as in the magnificent, day-flying Uraniid moth, *Chrysiridia madagascariensis (p. 33, middle)*, where the outer regions of the hind wings show a shifting play of colors from reddish purple to greenish yellow. In the American tropics are two species of *Uranidia* — a bit smaller than *madagascariensis* but with longer, more graceful tails on the hind wings. Their iridescence is more uniformly green.

A great many other moths and butterflies have this type of scale, the thin films of some being in the upper layer of the scale, of others in the lower one. In the latter case, the iridescent colors may be completely masked outwardly by a heavy pigment layer, and so be visible only when the scale is torn from the wing and turned over — a most curious instance of "a flower . . . born to blush unseen." The black scales of *madagascariensis* and of a

Scales of *Papilio*, greatly magnified, *top*, show iridescence. *Campylotes* has brightly colored scales forming rays along wing veins, *bottom*.



great many butterflies, including some of our North American Swallowtails, show this concealed blue iridescence on their lower surfaces.

It is inevitable that we should speculate about the possible reasons for such a multiplicity of colors and patterns. Such things do not evolve by chance; they must somehow benefit their possessors. The great majority of the moths and a large proportion of the butterflies are undoubtedly "cryptic" in appearance; that is, their colors and patterns so blend with their environments that predators such as birds, lizards, and praying mantids fail to perceive them. Many rather boldly marked species are actually strikingly cryptic in their natural environments, however conspicuous they may appear in a museum. The great, green, iridescent Imperial Swallowtail, *Teinopalpus imperialis, (p. 34)* spends much of its time among the foliage of lofty trees, where it is said to be quite inconspicuous.

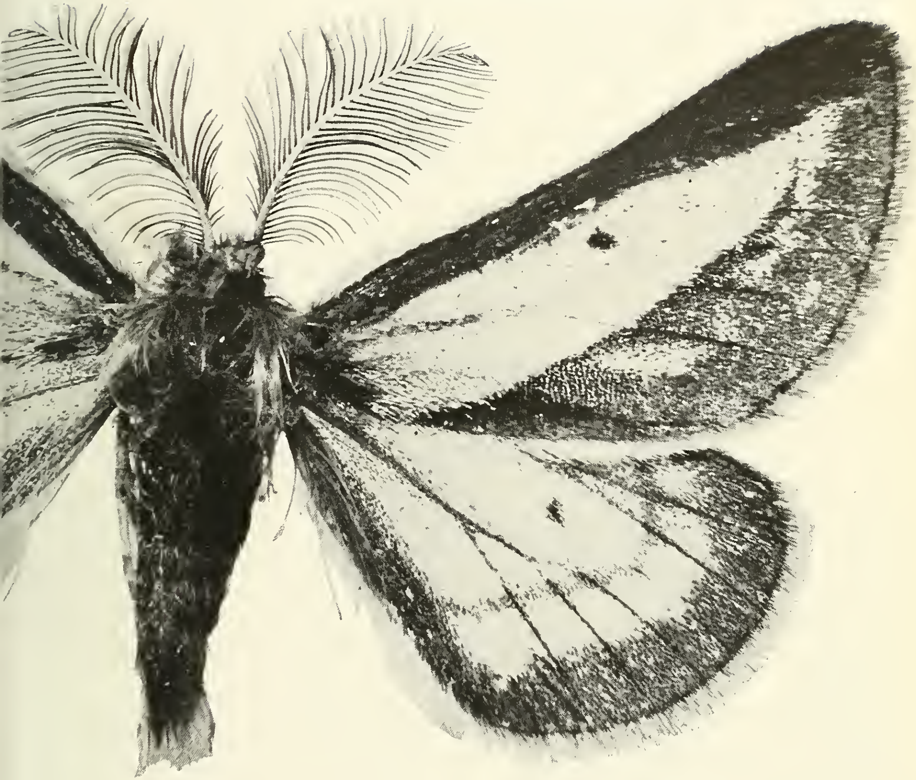
Many other bright colors and bold patterns function entirely differently, actually serving to attract the attention of predators. The possessors of many of these are genuinely protected by repellent or really poisonous secretions — some moths even secrete hydrocyanic acid, one of the most poisonous of all compounds to most forms of life. The showy, distinctive appearances are "aposematic," serving as an easily remembered warning of inedibility. And a great many other species, themselves quite edible, so mimic the brightly colored, inedible ones that they, too, gain a certain immunity from attack. The North American Monarch and Viceroy butterflies are our best-known mimetic pair; but there are thousands in the tropical regions of the world.

There remain many species that seem to be neither cryptic, aposematic, or mimetic, but yet are obviously successful in escaping enemies. In many such cases, a characteristic appearance may be of value in promoting male recognition by females, and vice versa, and in at least initiating courtships. It may thus more than compensate for the disadvantages of conspicuousness. Such species may be said to survive, at least in part, in spite of their appearance rather than because of it.

Large contrasting patches or bands of color may also act in another way — to break up the outline of the butterfly or moth into a number of seemingly unrelated forms that will not initiate an attack by a predator. Such "disruption" is a very important feature of much man-made camouflage. It can be especially effective in a rapidly and erratically moving object, such as a butterfly or moth in flight, where the sudden appearances and disappearances of contrastingly colored markings of the upper and lower surfaces of the wings create an illusive target *(see Nyssiodes lefuaris, p. 38-39; Battus brookianus, p. 33, bottom;* and *Colotis ione, p. 34).* We might note in this respect that not nearly enough is known about the abilities of many animals to discriminate colors or forms. We must therefore be wary about preconceived notions that a lizard or praying mantid, or even a bird or a monkey, sees a butterfly as the object we are conscious of seeing.

Eyespots, consisting of one or more contrasting rings about a central spot, are extremely attention-compelling objects to many animals, as experimental work has shown. They may be partly or entirely hidden and then suddenly displayed as a defense reaction. Such a sudden exposure definitely deters many predators. Birds and lizards do not, of course, "think" that the spots are the eyes of a large animal, such as an owl. They do not think at all, in the human sense. Perhaps for this very reason their chain reflex activities are all the more likely to be interrupted or blocked by sudden, drastic stimuli, to the great profit of the butterfly or moth. The enormous Owl butterflies, such as *Caligo prometheus (p. 31)* do not, of course, normally rest with their wings in the position shown by the specimen, nor does *Brahmaea wallichii (p. 30-31);* but when alarmed they do move their wings

Disruptive pattern of Japanese moth, *Nyssiodes lefuaris,* presents illusive target for predators. Feathery antennae are the insect's organs of smell.



to expose or vary the distance between eyespots in a very conspicuous way. So does our North American Io moth, and its relatives, the Polyphemus and Luna moths *(p. 34).*

A great many other eyespots, as well as other very conspicuous markings, some of which are iridescent, occur at or near the edges of the hind wings *(pp. 34, 35, 36).* There is no doubt that these often serve as targets to which the attack of a lizard, bird, or other predator will often be directed. Even if the attack is successful, the butterfly or moth will lose only marginal parts of the wings, with which it can perfectly well dispense, and will escape. One is reminded of the brightly colored, easily broken tails of many lizards and the prominent tails of many birds, which serve the same function. Field observations confirm the frequent value of such targets, and the study of museum series reveals the presence of many specimens with damaged hind wings that bear the marks of birds' beaks — evidence of a successful escape from a normal predator.

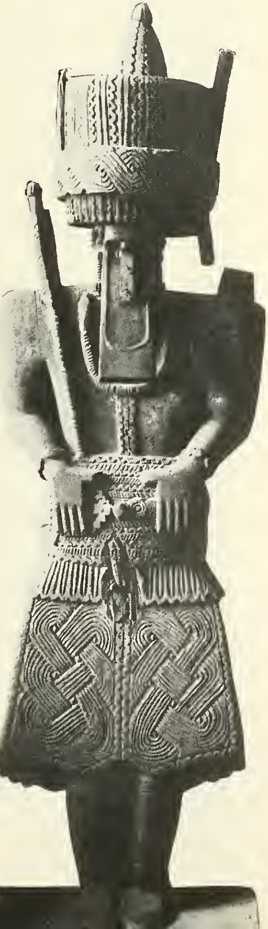
Even with these and other similar interpretations, however, we are still at a loss to account for many butterfly and moth patterns. We even know relatively little about the extent to which most of our common moths and butterflies are attacked by birds. The subject offers a most interesting field for much additional observation and experiment by both naturalists and animal behaviorists.

Funerary Figures of the Kafirs

By Douglas Newton

To the Western imagination, Afghanistan still, perhaps, retains something of its nineteenth-century position as a border state. In those days, as the North-West Frontier Province, it was a theater of open war. Less openly, it was the cockpit where the diplomats and secret agents of England and Russia performed the intricate moves of Kipling's "great game," in which India was the stake. But two thousand years ago, the area of Afghanistan was something more. It was provincial, indeed, but a province of great empires – Persian, Greek, Indian. Across the country ran a stretch of the Silk Road from the Mediterranean to the Far East, one of the great trade arteries of the ancient East. Through Afghanistan for centuries there poured the cultural forces of the world—including art styles—and actual populations of Dravidians, Indo-Aryans, Greeks, Scythians, Kushans, Hephthalites, Mongols, and Turks. This rich continuity was shattered by the devastations of the Mongol troops of Genghis Khan for eight years (1219-1227). Nevertheless, one of those incursions left behind it a human residue that to this day inhabits the high valleys of the Hindu Kush. These people still go by the name that was given them by their Moslem neighbors: Kafirs, or Infidels.

The existence of these pagans may have been known to Arrian and Strabo, Alexander's chroniclers, and to Marco Polo; they were invaded by Tamerlane, and in turn invaded Baber's possessions. They were visited sporadically by Europeans during the early nineteenth century – or visited them, as when British troops invaded Afghanistan in 1839. Then a party of about forty, preceded by bagpipes, entered the lines and claimed blood relationship with the political representative, Sir William Macnaghten. Diplomacy failed the Englishman; he seems to have met this claim without humor or curiosity. The Kafirs were summarily packed off, and when they left they disappeared from European view for another half-century.



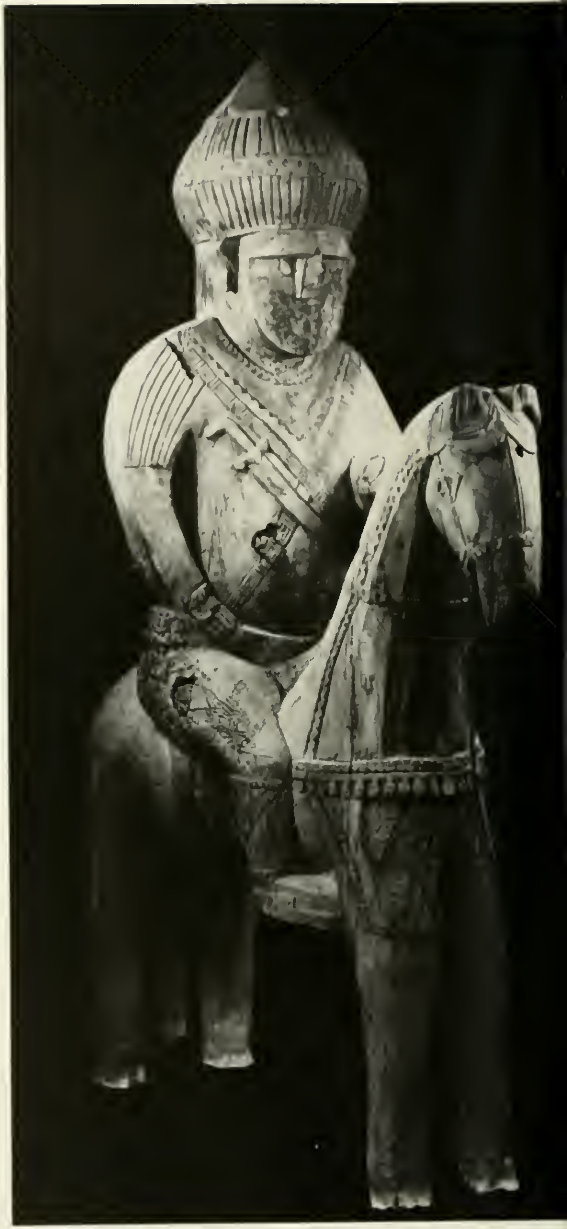
Figure, probably of god Imra, *right*, shows strapwork designs typical of the art and architecture of Presun Kafirs. Crosshatchings and cowrie shell eye are seen in the head detail at the left.

Then, however, Sir George Robertson made his way into their remote valleys and stayed for a hazardous year (1891) gathering information about them. His timing was fortunate. In 1895, the British recognized Afghan authority over Kafiristan. It promptly became a closed land, from which came only dreadful rumors of violence and forced conversion. When the curtain lifted again, Kafiristan had disappeared, and in its place was Nuristan, the "Country of Light," and its diminished population consisted of devoted Moslems. Today only three valleys in Chitral, a part of Pakistan, are inhabited by a branch of Kafirs – the Kalash – who retain the old religion (Natural History, November, 1959). Even among them it is dying out rapidly. Six out of ten are Moslems, and the proportion is increasing. And even now, little more is known about the Kafirs than Robertson recorded. The two or three anthropological expeditions that have visited them during the last fifteen years have not yet published their results in full.

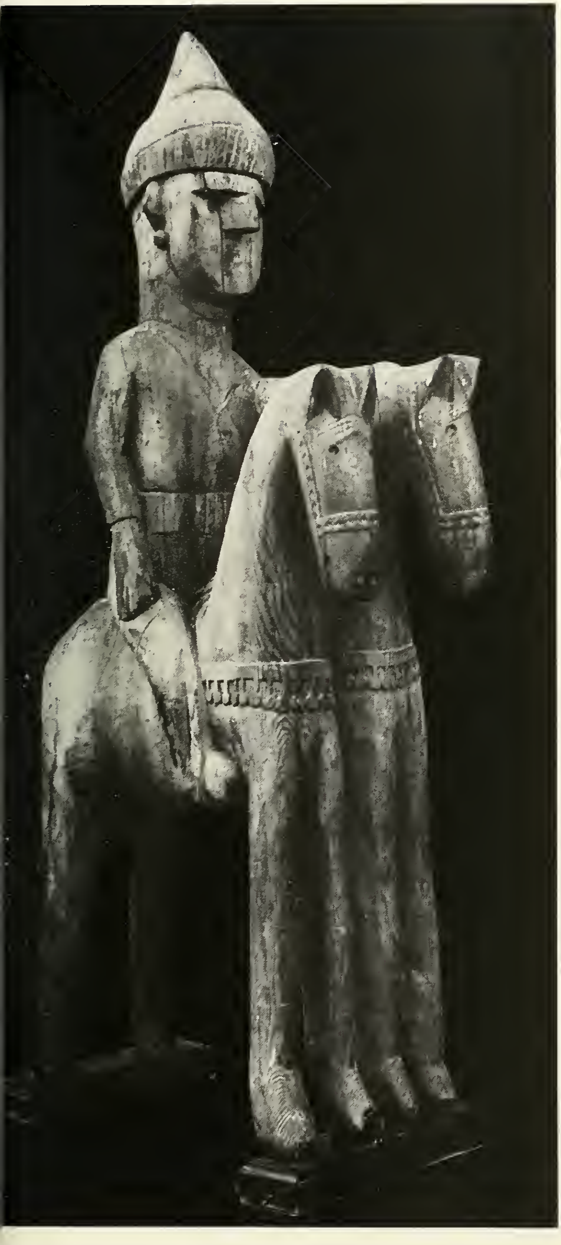
Apart from a few decorated metal objects, the chief art of the Kafirs is wood carving, and this is dedicated to the service of religion and of the dead. Religion calls for wooden outdoor altars, with rows of horses' heads overlooking the threshing floors, and stone temples with wooden doors and columns. In every case, the wooden components are elaborately carved with abstract designs and stylized heads of rams and horses. The position of the goat in this complex is reasonable enough. The goat may have been first domesticated in these regions, and it is today not merely a beast of great economic importance but an object of great religious veneration. The horses are a different matter; the Kalash keep no horses and rarely see them. They are totally unsuited to existence in the surroundings offered by these mountain valleys. But the conception of them as animals of importance that bring prestige to owner and rider seems to figure strongly in Kafir imagination. Among others, Robertson described a building of the Presun Kafirs of Nuristan that was on a noble scale. Dedicated to Imra, the Creator, it was sixty feet square and twenty high, with a portico almost as large. Flanking the seven doors were eight colossal seated figures of the god, and Robertson's description makes it clear that they were in the same style as that illustrated on pages 40-41. There were five other huge figures of Imra, together with a great number of carved columns and panels and other decoration.

Practice in the arts varied from tribe to tribe. It appears that although the Presun were notable architects and sculptors of the divine figures described, they had no funerary effigies. The Kalash, on the other hand, are prolific carvers of funerary figures but have no images of divinities, with one exception. This is a small, stylized figure of the goddess Dezalik, which is kept in a house where women are confined at the time of childbirth.

The Presun temple disappeared during the Afghan conversions; temples still existing are not of great importance, nor will they increase in number. The most active branch of Kafir art consists of the commemorative funerary figures, which are made to this day, and seem to be of two types. Some, placed at the entrances to the villages, are about eighteen inches high, set on the tops of posts seven or eight feet high. The better-known type comprises large, up to



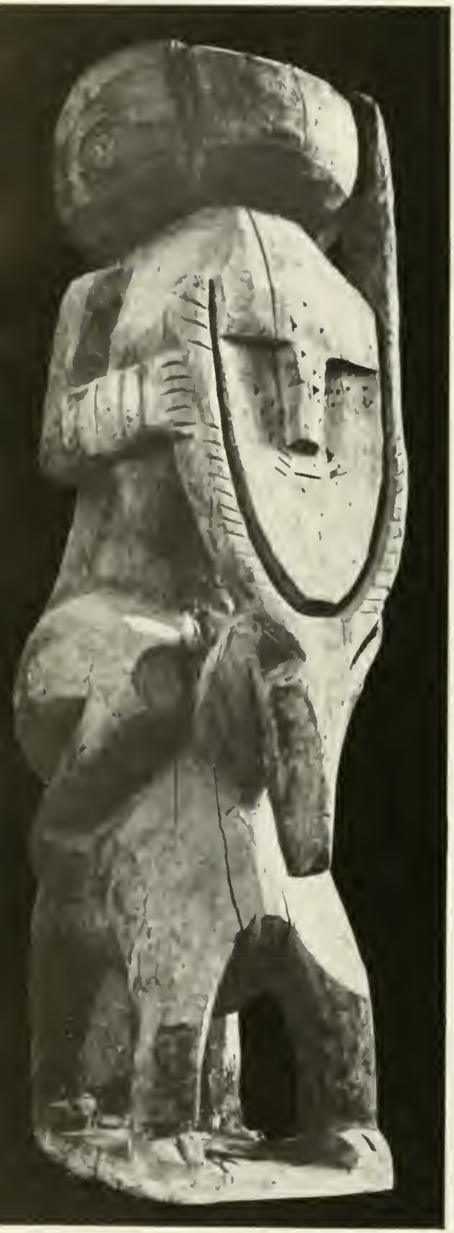
KALASH keep no horses, but they are represented in art as prestige figures. These two riders must honor extremely important men; an elaborate, three-day feast probably attended the ceremonies when the statues were set in position.

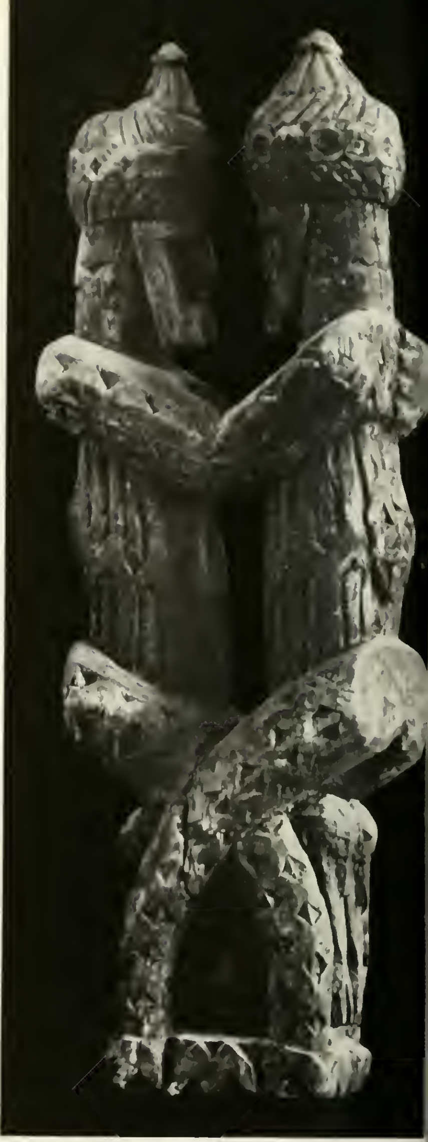


life-size figures kept in graveyards. These are propped rather negligently against the aboveground sarcophagi of rough wooden planks in which the corpses are deposited.

Both men and women are honored by these effigies — ironically enough, since in their lifetimes women have a notoriously low social position among the Kafirs. Probably the most likely explanation for this attention is not belated respect, but rather attempts by relicts of the deceased to seize any opportunity to make a bid for prestige. The type of figure dictates the magnitude of the feast that must be held on the first anniversary of the funeral, at which time the statue is set in place. An ordinary standing figure entails one day of celebration; anything more elaborate calls for up to three, with proportionate expenditure of food. On the whole, these are cheerful occasions. A Kafir traditionally faces death rather lightly: his typical dying words are, "You may punish me, O God—but I have enjoyed myself."

THERE are several types of grave image. Each has its own name, although these are not particularly enlightening: figures of women, for instance, are called "Jukor Dázi," which literally means "figure of a woman." Men wear turbans, women a kind of crescentic cap, otherwise they are not distinguishable. All have the same half-moon face with straight brows, straight noses, glaring eyes and teeth inset with cowries or white stones. (Does the square chin of Imra's face denote some distinction between the human and the divine?) Some of them repeat the themes of the small post figures. They show notables, male or female, enthroned. One rare example has a man seated on a horned animal that can hardly be a goat. It is probably an ibex or a markhor, beasts that are ritually expelled at the winter solstice to insure the fertility of the goats. Others are mounted on horseback — some figures, with remarkable equestrian virtuosity, bestride two steeds simultaneously. The trappings of the horses are rich in tassels and ornamentation, if rather haphazard in arrangement: one can imagine a rider managing a mount without a saddle, but not without the reins. This functional vagueness suggests that most of the artists have not really bothered to work from a live model, or indeed, have never even seen one.





Two figures, *above*, possibly were made in commemoration of a fight, or they may represent deaths of two relatives.

Markhor's horns frame the face of figure at left. Its style indicates it might have been made by pre-Afghan Kafirs.

Typical Kalash head has inlaid teeth, possibly of white stones. The infilling of one of the eyes has disappeared.

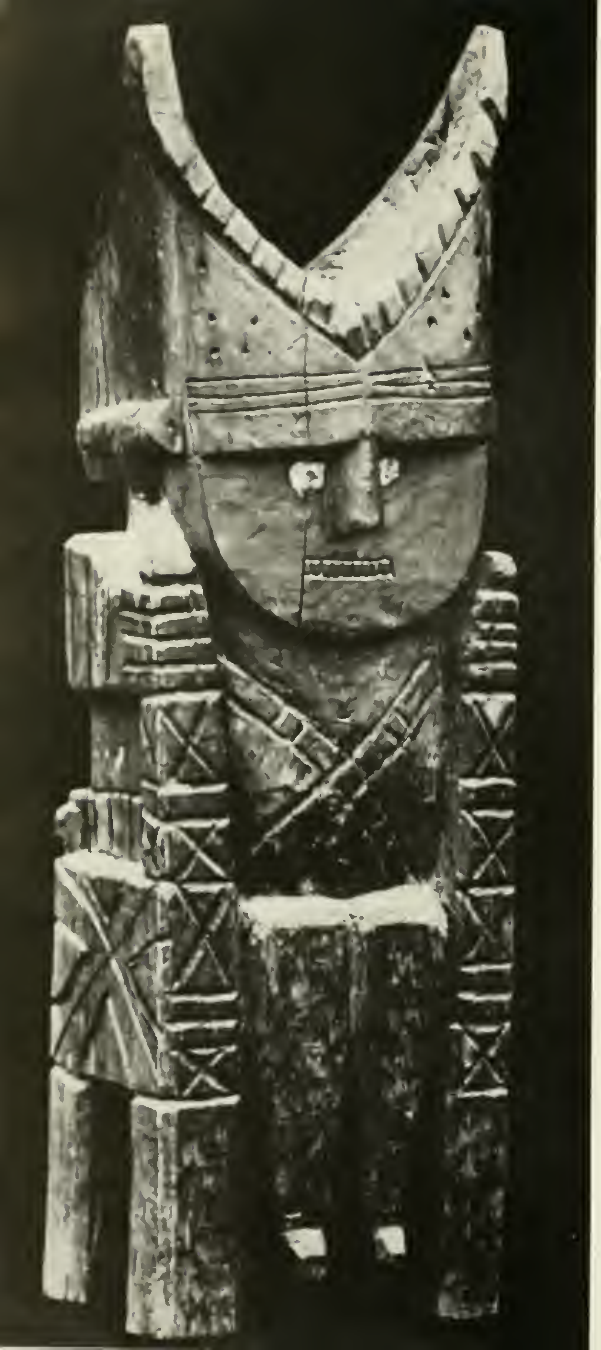
An even more convincing demonstration of this are the horses themselves. They are completely Noah's Ark beasts, each about as much like a horse as a stuffed llama would be. Flaccid and tubular, they balance indecisively on sagging legs, which end dubiously only in would-be hoofs. On the other hand, their riders, planted firmly on their backs, have a genuine authority, poised and rather lowering. The formal transition from the horses' barrel-like bodies to the men's flattened torsos is ingeniously managed by rounding the riders' thighs to accord with the forms nearest them.

The great majority of the figures, however, are standing, and in spite of the fact that women as well as men were honored with these figures, the surviving examples seem to be predominantly male. Invariably, the men wear embroidered trousers, a tightly belted blouse, and a pointed turban. They carry weapons—clubs and battle-axes—and are marked with indications of scars and wounds. This traditional costume survives even on present-day effigies, although in practice every Kafir wears baggy trousers, a European-style shirt hanging outside, and a cap. Life-size or larger, the figures are rather flat, tending to be two-dimensional forms with highly decorated surfaces that indicate folds in fabric, woven or embroidered patterns, baldrics, and necklaces, which are marks of rank. Large rosettes often appear on the backs. Only above the flat, half-moon faces does the sculpture swell out into convincing three-dimensional form in the bulbous, yet tapering bulk of the turbans.

The finest of these big figures depend for their effect on simplicity. They are perhaps oversimple: they depend too much on the opposition of a few plain geometrical shapes — the curve of the chin against the straight eyebrows, the ellipse of the arms against the stiff, straight sides and hem of the blouse. The result is often imposing, sometimes almost monumental — but never quite. The stylistic means fall between two stools. Their naturalism is not quite sufficient to vitalize their rigidity, which as a result tends to have the uninteresting qualities of an exercise in geometry. Ideas about diffusionism in the arts are rather the rage just now, and interesting — not to say astonishing — structures can be fabricated on the incidence of designs and motives. To a good diffusionist, the Kalash figures can offer a rare treat. Are there African affinities here? The faces are virtually identical with masks from the Toma of Liberia; the elaborate guilloche designs repeat a typical decorative feature of the court art of the Bini of Nigeria. One could, indeed, build up a theory of Afro-Afghan relations that would be delightful and wholly misleading — both in terms of history and of art.

THE nearest affinities to the sculpture of the Kafirs, however, are still removed by impressive degrees of space and time. Twelve hundred miles away to the southeast live the aboriginal tribesmen of Central India. They have arts of their own. They practice sculpture, painting, and the crafts, and their work is more or less incompetent. Even Verrier Elwin, their warmest advocate, does not claim very much for them. He admits their achievements are "meager and inferior" compared to those of Papuans, Africans, and Northwest Coast Indians. But he begs his readers not to compare the work of vigorous, influenced tribesmen with that of villagers who are living in "economic and cultural debris." But, uninspired though it may be, it nonetheless offers considerable fascinating material for comparison.

It is not very clear just what member of society in these tribes carries out the actual work of wood carving: often enough the work seems to be a change-of-pace job or busman's holiday for the village carpenter, who works on commission. But one interesting aspect of this casual approach is that the carpenter is not necessarily a member of the same community, faith, or ethnic group. The Bison-horn Maria of Bastar, India, for instance, set up fine pillars as funerary monuments. Each of the four sides is carved



in relief with emblematic scenes, and the top is elaborated with birds in the round, or with geometric forms, one of which may well be a turban. These pillars are commissioned by the Maria, who presumably specify the designs they want, but the work itself is carried out by Hindu artisans.

Another notable branch of wood carving among these people is seen in the wooden doors of certain tribes to the north of the Maria, among them the Gond, the Baiga, Santal, Kond, Juang, and Saora. Here again there occur reliefs of a naturalistic sort surrounded by bands of geometric decoration, and here too – among the Konds – some doors are made by Hindu carpenters, although others are certainly made by artisans among the tribesmen, themselves.

WHATEVER the other difference between them, there is little to choose between the work by tribal and extratribal craftsmen. Both share a reliance on bands of squares cut by diagonals, elaborate guilloche strapwork, and rosettes of many varieties. These designs, then, are part of a popular tradition that extends over a huge area of the hilly regions of central India. But, as has been stated, they are also absolutely characteristic of the art of the Kafirs. Where did they come from, these designs that unite, if only in one tiny aspect of thought, such distant places?

It appears that these isolated aboriginals were as unaffected by the great metropolitan styles of India as those styles were by Kafir work. It seems certain that the erection of monumental pillars is a native Indian custom of very considerable antiquity; not one introduced in comparatively modern times. The decoration superimposed on this basic form also may well be of ancient inspiration. Verrier Elwin believes in the persistence of some geometrical designs in Indian tribal art from early times, citing their appearance on Indus pottery.

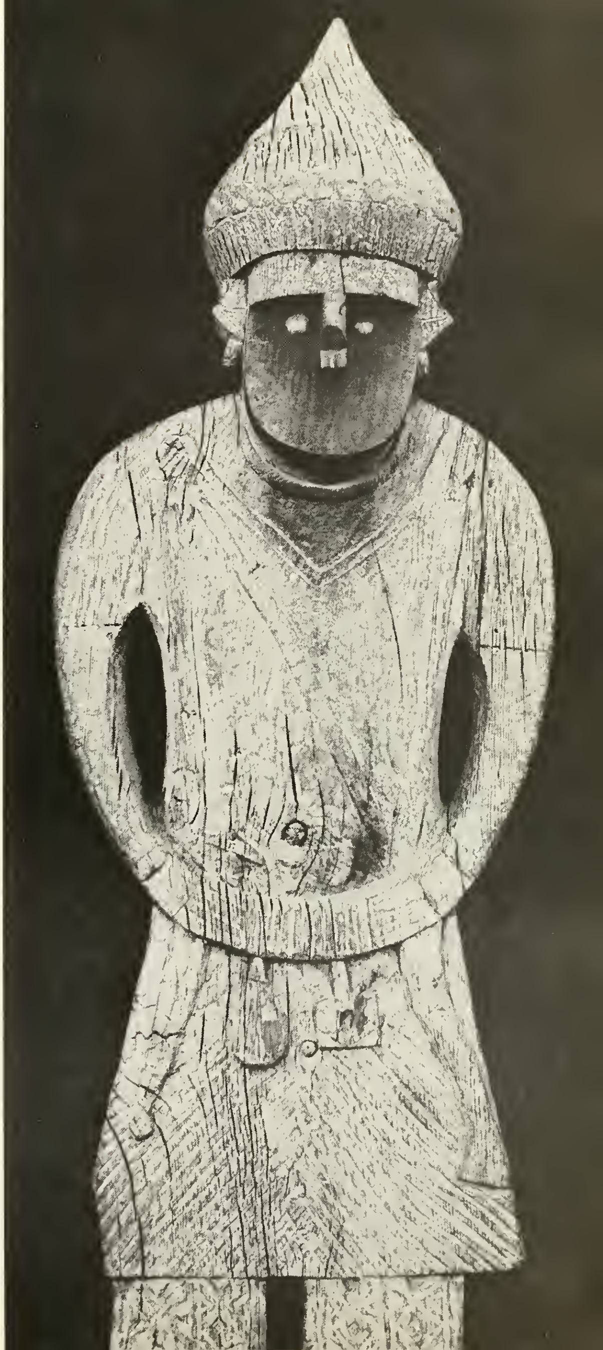
Possibly the rosette is another such fossil. It makes an early appearance on a column capital from the palace of Pataliputra. This great city was the creation of Chandragupta, who seized power in the wreck of the Persian Empire that followed the fall of Persepolis

WOMAN on throne wears hat unlike any worn by Kafirs; it is purely art form.

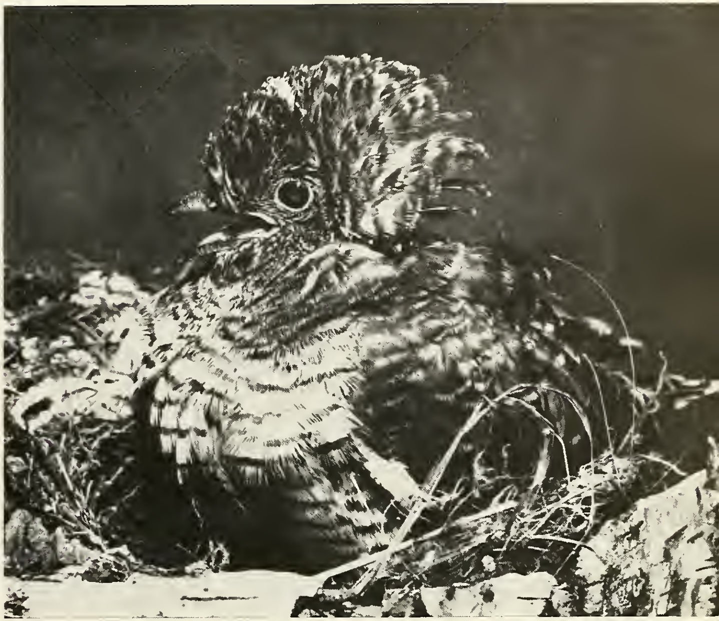
in 330 B.C. Chandragupta's grandson was the even greater Ashoka, whose achievements as a lawgiver were embodied in his famous multilingual edicts. These extraordinary ethical and religious documents were given permanent form by being carved on thirty-odd memorial columns. They were not of mere wood, to be sure, but of polished sandstone, and in the style of the displaced Achaemenid overlords. The most famous of these Ashokan monuments — it is now the official emblem of India — is the capital from Sarnath. It is crowned by the forequarters of four lions, glaring to the points of the compass, and below the forepaws of each of the animals is a large and distinctly designed rosette.

The setting-up of commemorative columns may be an Indian rather than a Persian trait, but the forms of Chandragupta's and Ashoka's columns were certainly set by Persian models. They share the characteristics of the great capitals of Persepolis — the opposed animals, the huge volutes, the decorative rosettes. It has even been suggested that the execution of the Indian examples was the work of imported or refugee Persian craftsmen. This is curiously reminiscent of the relations between the Maria patrons and the Hindu executants, and even of those between the Kafir aristocrats and their subservient craftsmen.

We have, then, a picture of hybridization between the Indian pillar and Persian decoration. And we may see it as penetrating to the hills of Afghanistan and central India, and persisting there while new ideas and new kingdoms swarmed across the lowlands. We may look with a new sympathy at the ram head and horse head capitals of the Kafir temple columns if we see in them the conceptions of the palace of Darius. To be sure, they subsist only in a crude peasant version — in the work of people ignorant of their distant glories. They survive precisely because of that ignorance, and the people's remoteness from a world in which change could have occurred. In the stiffness of the Kalash grave figures we may perhaps glimpse something of the formality of the ancient Persian court; in Imra's great chin may be the beard of the King of Kings; and in his monstrous hat the Achaemenid crown.



MAN's clothing is not in Kafir style, but resembles old Persian court dress.



Tree sparrows usually eject cuckoo egg; one at left answers hungry cry of the fledgling reared by spotted flycatchers.

Tiny flycatcher's nest barely holds the cuckoo, which has displaced the rightful young. Adults cleaned nest each day.

The Ways of a Parasitic Bird

By Károly Koffán

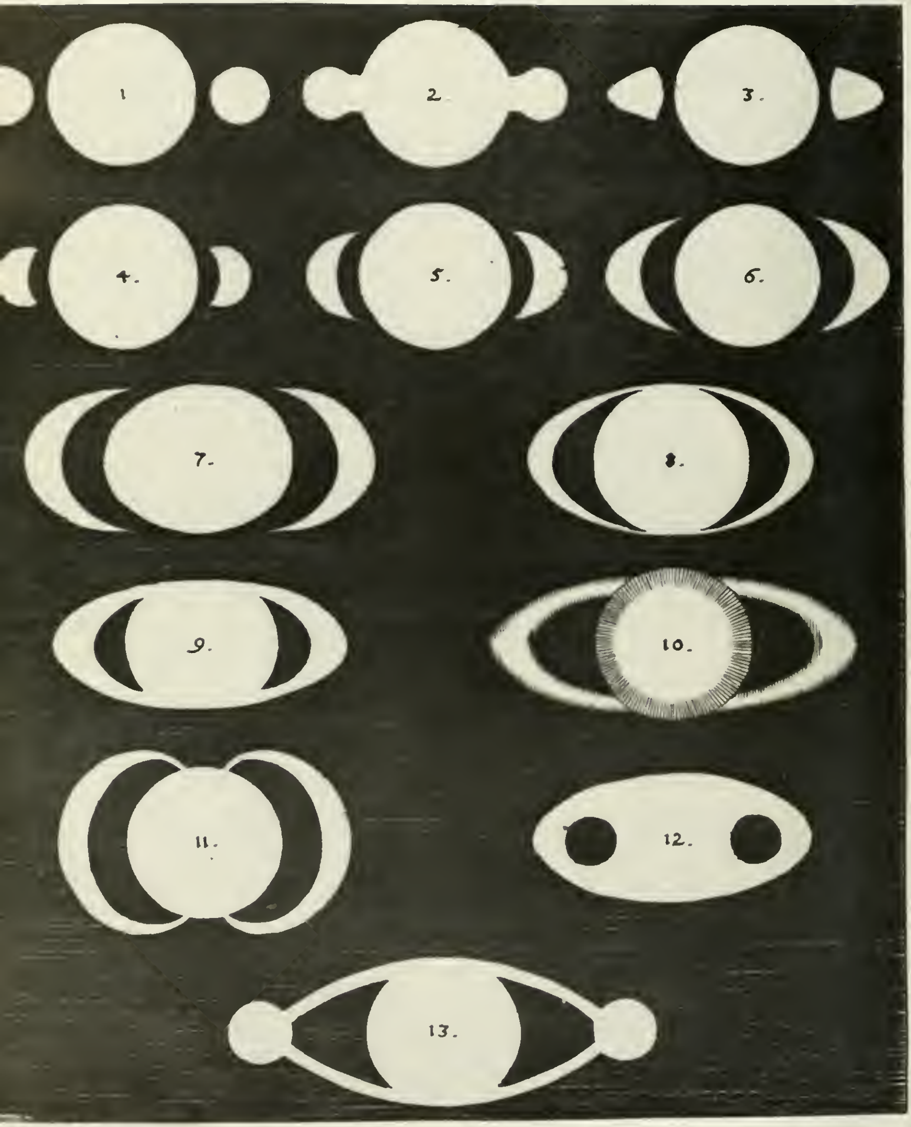
Most birds raise their own young —not so the European cuckoo. It never builds its own nest, but victimizes other species in whose nests it lays eggs. I have seen some discriminating birds push cuckoo eggs out of nests, but most will incubate and then feed the young cuckoo, even if it means the destruction of their own offspring.

The female cuckoo is no respecter of others' size. She frequently leaves her egg in the nests of much smaller species. As the young cuckoo grows, the parasitized adults may be faced with a feeding task for a single "adopted" cuckoo equal to that of feeding six of their own young. Fortunately for the intruder, many female birds exhibit interest in any orphaned fledgling. As a result, the adults of several species may simultaneously feed an abandoned cuckoo.

In taking the photographs shown here, I discovered how effective the ceaseless, urgent bawling of the fledgling cuckoo can be. Spotted flycatchers had begun raising young on my window sill, and I transferred a newly hatched cuckoo there from a distant wood lark nest. Earlier, these flycatchers had evicted a cuckoo egg, but now I rejoiced as they accepted the tiny, hatched cuckoo as their own. Even after the newcomer ejected the rightful young from the nest—I had reconciled myself to this eventuality —the foster parents dutifully fed it, spurred to active food-gathering for hours on end by the seemingly tireless bawling of the fledgling.

Soon the young cuckoo had surpassed the size of its foster parents, growing to twenty times its birth weight in twelve days. I moved the bird to a birch stump, where, after more than a month, its urgent cries still enslaved its wearying foster parents and birds such as the sparrow pictured atop its back. Finally, its male foster parent left, but the female continued beyond my own endurance.

PERSISTENT CRIES of th cuckoo attracted a flycatcher *left*, and a sparrow, *right*, plu warblers and song thrushe Adults bore earthworms grubs, caterpillars, and othe morsels to push down cuckoo' throat. When young bird flie it often lures its helpful foste parents over great distance



Saturn's appearance was depicted differently by several observers between 1610 and 1650, the first four decades of telescopic observation. Huygens, who discovered Saturn's rings, also gathered and published the earlier renderings.

SKY REPORTER

Saturn, second largest planet, has a unique system of rings

By Simone Daro Gossner

V · SATURN · SATELLITES PRIMUM COGNITI
M DC LXXXVI

Medal shows Saturn and five satellites.

Until two centuries ago, Saturn appeared to be the last outpost of the solar system. The "seventh sphere" of Ptolemaic astronomy, it was long believed to be merely a short distance away from the "sphere of stars," the ultimate boundary of the medieval world. Since then, modern discoveries have added a few more distant members to the sun's family and have led us to revise our views on the cosmic scale of distances. Yet our knowledge of Saturn's physical nature has not progressed much beyond some well-established generalities.

Second in size only to Jupiter, Saturn has a diameter of 75,000 miles at the equator. The length of its day cannot be measured accurately for want of permanent surface markings, but it has been estimated at about ten hours and twenty minutes. This rapid rotation causes a noticeable flattening at the poles (measured between the poles, Saturn's diameter is only 66,000 miles). The planet takes twenty-nine and a half years to complete one revolution around the sun, at a distance of nearly one billion miles.

In composition, Saturn is probably similar to Jupiter. The spectrum of its atmosphere shows it to have more methane and less ammonia than the latter. Owing to its greater distance from the sun, however, its surface temperature is far lower than Jupiter's. Therefore, it is believed that most of its ammonia has turned to ice crystals and has sunk lower into its atmospheric depths, thus being less conspicuous in Saturn's spectrum. On the other hand, the absence of ammonia clouds permits us to probe more deeply into the methane region, which enhances the corresponding spectral features. As on Jupiter, both these gases are only minor constituents of the atmosphere, which is thought to contain mostly hydrogen and helium. Nothing is known about the nature of the planet's deep interior.

Saturn's unique system of rings, visible only through a telescope, caused much puzzlement among early observers. The many imperfections and low magnifying power of their instruments made the rings appear as curious appendages. The drawings of the planet's odd shape during the first forty years of telescopic observations *(see picture, opposite)* were often nearly correct, but no one surmised that Saturn's appearance was caused by a ring until Huygens solved the riddle in 1655. Unsure of himself until he could obtain further observational confirmation, but anxious to secure credit for the discovery, Huygens disguised his announcement in a cryptogram printed at the end of one of his publications. Unscrambled, the resulting Latin sentence revealed that "It [Saturn] is girdled by a thin plane ring, nowhere touching, inclined to the ecliptic."

Modern observations have disclosed that Saturn has not one but three distinct rings. The over-all diameter of the system is about 170,000 miles. The outer ring is 10,000 miles wide. The middle ring, which is much the brightest, is 16,000 miles wide and is separated from the outer one by a 3,000-mile gap called *Cassini's division*. The innermost ring is considerably fainter; its dusky appearance has prompted the name "crepe ring." All three lie in the plane of Saturn's equator. In contrast with its wide extent, the ring system is at most a few miles thick.

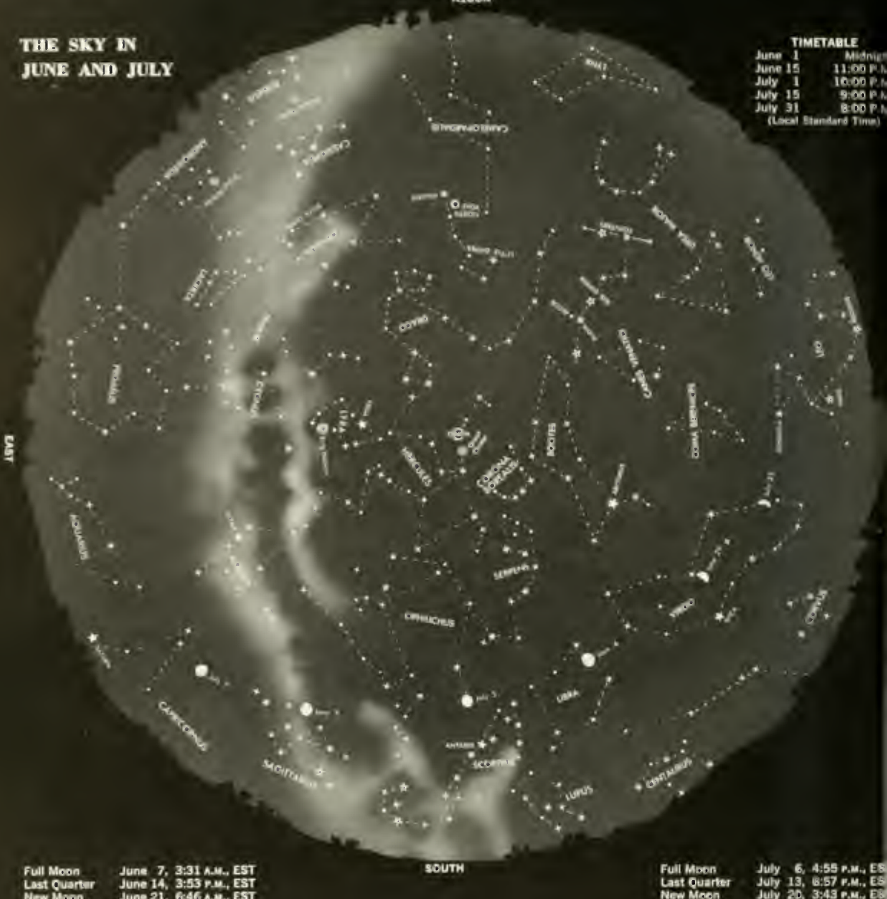
Although the rings look solid when seen through a telescope, spectroscopic studies disclose that they consist of innumerable tiny fragments revolving around Saturn, each in its individual orbit. The particles may be plain snow or snow-covered pebbles. Depending on the planet's position in its orbit, we see the rings alternately as a wide ellipse or as a thin, nearly disappearing line.

While observing the rings, Huygens discovered Saturn's first satellite. Named Titan, it is the second largest satellite in the solar system (Jupiter's Ganymede is largest), and the only one known to have an atmosphere. Four more were discovered in the same century by Domenico Cassini, of the Paris observatory: Iapetus in 1671, Rhea in 1672, Tethys and Dione in 1684. By that time, Saturn was leading Jupiter in total number of known satellites, and a medal was struck in 1686 *(see picture, above)* to commemorate the event. Ironically, one side of it bears a profile of Louis XIV, who basked in the glory of the discoveries, but Cassini's name does not appear.

At present, nine satellites of Saturn are known. Mimas and Enceladus were added by William Herschel in 1789, Hyperion by William Bond in 1848, and Phoebe by William Pickering in 1899. Except for Titan, all the satellites are small, with diameters ranging from one hundred to eight hundred miles. Their low densities suggest that they may contain a preponderance of ice and snow. The outermost one, Phoebe, travels in a retrograde orbit.

On these pages Mrs. Gossner presents the sixth in her 1963 series—a co-ordinated review of the solar system.

THE SKY IN JUNE AND JULY



TIMETABLE

June 1	Midnig
June 15	11:00 P.M
July 1	10:00 P.M
July 15	9:00 P.M
July 31	8:00 P.M

(Local Standard Time)

Full Moon	June 7, 3:31 A.M., EST
Last Quarter	June 14, 3:53 P.M., EST
New Moon	June 21, 6:46 A.M., EST
First Quarter	June 28, 3:24 P.M., EST

Full Moon	July 6, 4:55 P.M., ES
Last Quarter	July 13, 8:57 P.M., ES
New Moon	July 20, 3:43 P.M., ES
First Quarter	July 28, 6:13 A.M., ES

For the visual observer:

Mercury will be at its greatest western elongation on June 13. This will not be a favorable elongation, and the planet will be observable, low in the eastern sky, for only a few days in mid-June. In superior conjunction on July 13, it will be too near the sun to be seen that month. Mercury will rise forty-five minutes before the sun on June 1, one hour before on June 15, forty-five minutes before on July 1. After conjunction it will be in the evening sky, setting with the sun on July 15, and forty-five minutes after on July 31

Venus (—3.4 magnitude) will rise approximately one hour before the sun in June and most of July. This time interval will then decrease gradually to about thirty minutes on July 31. The planet will be low in the east at sunrise.

Mars, in the western sky at dusk, will set at about midnight, local standard time, on June 1, 11:00 P.M. July 1, and 10:00 P.M. July 31. Located in Leo, it will pass one degree north of the star Regulus in early June. Its magnitude will fade slightly, from +1.2 in early June to +1.6 in late July.

Jupiter, in Pisces, will rise at 2:00 A.M., local standard time, on June 1, shortly after midnight on July 1, and at 10:30 P.M. on July 31. The planet will brighten from —1.8 to —2.2 ma nitude in the course of the two-month period.

Saturn, in Capricornus, will rise at midnight on June 10:00 P.M. on July 1, and at 8:00 P.M. on July 31. This plan will also brighten by nearly half a magnitude, from +0.9 early June to +0.5 at the end of July.

The summer solstice will occur on June 21 at 10:04 P.M EST. Two weeks later, on July 4, the earth will be at aphelio its greatest distance from the sun.

A meteor shower, the Delta Aquarids, may be expected o July 29. Past performance indicates that a maximum twenty meteors per hour may be attained.

A partial eclipse of the moon, on the evening of July will not be visible in North America.

The total eclipse of the sun on July 20 will be remarkab in that the path of total phase will cross more land tha water. Starting in northern Japan at sunrise, it will reach th Alaskan coast near Nunivak Island and will pass north Anchorage. It will then follow a southeasterly course fro the Yukon to the southern tip of James Bay and on to th Maine coast, passing over Bangor in the late afternoon.

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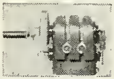

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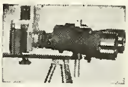

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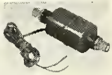

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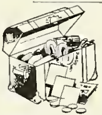

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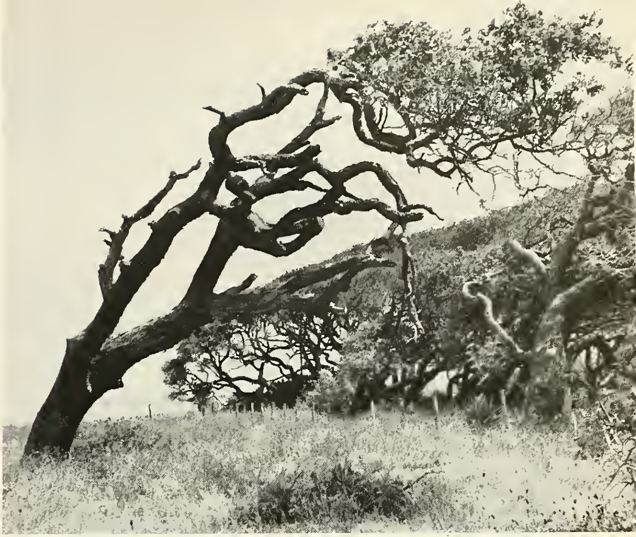


Bending away from the sea, wind-swept trees, *above*, characterize Live Oak Peninsula, north from Corpus Christi.

Gulf storms deform oaks of coastal Texas

By Marion Whitney

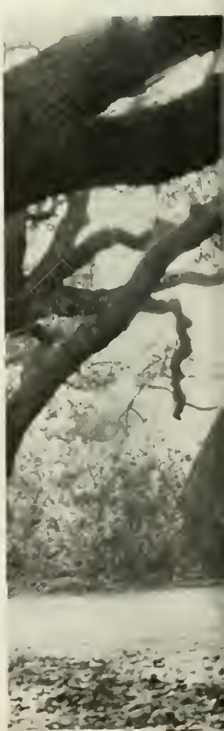
There is a charming bit of the long and curving Texas coastline called Live Oak Peninsula where oaks *(Quercus virginiana)* have been permanently molded into grotesque positions by the constant, 25-35 mph gales that blow landward from the Gulf of Mexico. Beginning north of notably beautiful Corpus Christi Bay, Live Oak Peninsula extends forty miles northeastward. The town of Aransas Pass is at its juncture with the mainland, Rockport is near its northern end, and Copano Bay separates it from the mainland of Texas on the west.

Live oaks are also found in gravity-defying stances in nearby Goose Island State Park to the north across Copano Bay, and scattered, stately individual trees grow to majestic proportions over much of the Gulf coastal plain, but only in the peninsular sands near Rockport do these picturesque, twisted trees abound. In one area, thickets of short oak are so dense that a man could not walk through them without the help of an ax.

Low, sweeping trees grow almost to the margin of the bay. The closer they come to the sea, the more nearly recumbent they become, forming a sloping and distorted "wall" as a buffer against the gales. At acute angles of thirty degrees, the seaward oaks rest on smooth elbows that touch the sand. Their stoutest limbs drop down and bury themselves two feet or more in the white sand. Then, farther out from the center of the tree, these same limbs rise again at a low angle, and thus act as props to maintain the stability of the tree's crown and to help hold the tree in the loose sand during storms. There is a tree about twenty-five feet from the water's edge that all but lies on its side, whereas a few hundred yards inland, trees may stand erect if the grove is dense enough to protect them from the wind's intensity.

Oaks scattered over inland areas grow together in communities of several trunks that share a common crown. These groves resemble hillocks, and are called mottes. When cleared to walk under, the mottes along the shore are as inviting as those inland. Trunks near the sea grow shorter than those on the landward side. Seaward trees usually begin to branch about four or five feet from the ground, while those on the inland side of the motte may have branches that start as far as

INCLINING GROVES, like that *above*, probably provided a refuge for the Karankawa Indians under a roof of limbs.



BECAUSE they resist heavy worm attack and wind, oaks, *right*, are named "roughnecks" by peninsular inhabitants.

SEAWARDMOST members in grove, these trees form prow that breaks wind, permitting inland oaks a taller growth.

wenty or twenty-five feet up the trunk.

The crown of each oak on the windy ide of a clump overlaps the trunk and art of the crown of its nearest landvard neighbor. Thus, trees form a ompound crown, which slopes up venly—rather like a shed's roof—from he level of the shore on the seaward ide of the community to heights of as nuch as forty feet at the grove's leevard edge, where it stops abruptly. ome indigenous shore birds build heir large platform nests atop the lense compound crowns of the mottes.

In the days prior to the white man's lominance of the area, these groves vere probably important shelters for he Karankawa Indians. It is said that he Karankawa tied the limbs together, r bent them and tied them down to nark trails through the groves. They night have bent the trees for use as raps, as well. Today, a number of mbs have grown together, as if once ied, and it was near such an arrangenent that I found an arched trunk that id not conform to the normal orienation but, instead, bent parallel to the shoreline. This might well have been a marker or a trap set along an old Indian trail.

Although the usual oak found near the water is unsymmetrical and highly inclined, there is, in Goose Island State Park, only a few hundred feet from the shore, a famous and erect giant oak locally called "Big Tree."

Big Tree's main trunk is no more than four or five feet high to the point where branching begins, but is ten to twelve feet in diameter. Above its squat base, this oak branches with a profusion of stout, twisted arms that give it the look of a Medusa-head. The tree is considerably taller than most of the coastal oaks, and it has a spread of 135 feet across its crown. Some scientists think the Big Tree is the result of a fusion of three trees and that it is about 2,500 years old. When its seedlings first pushed above the sand, the coastline may have been different from its present contours. Perhaps an erstwhile motte, long since extinct, protected this composite tree from the winds and permitted it to grow straight. Whatever its history, it stands erect and symmetrical in the midst of a grove that leans toward the ground.

Inhabitants of the peninsula say that man is the greatest enemy of the trees. If men can be held back in their destructive march upon the beauty of the peninsula, it is felt the oaks will more than hold their own against the constant winds and the voracious woolly worms that come by the hundreds of millions every spring to feed on the tender young leaves. Perhaps just as dangerous for the trees as those who come with bulldozers are those well-meaning men who use tree surgery and sprays to help the oaks survive. Inhabitants fear that such attentions may soften and weaken the trees, which are unused to such treatment.

Naturalists believe that if the ax and the bulldozer can be effectively checked, the oaks will always manage pretty well without surgery, sprays, or pampering of any sort; they point to the monumental Big Tree, which has so successfully weathered the centuries.

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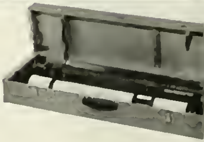

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About the Authors

A total solar eclipse in Alaska, which will occur on July 20, 1963, and various celestial oddities of the forty-ninth state are discussed by DR. THOMAS D. NICHOLSON in "Lunar Shadow on Alaska." Dr. Nicholson is Assistant Chairman and Astronomer at THE AMERICAN MUSEUM-HAYDEN PLANETARIUM. Mr. Helmut Wimmer, who illustrated the article, is staff artist at the Planetarium.

DR. H. HEDIGER, Director of the Zoological Garden in Zurich, Switzerland, describes the strange lure mechanism of the alligator snapping turtle. Mr. H. Hensser. a zoologist who assists Dr. Hediger, made the photographs.

The nature of coral banks is explored by DR. DONALD F. SQUIRES, who is with the Smithsonian Institution's Division of Marine Invertebrates. He was formerly a member of the Department of Fossil Invertebrates at THE AMERICAN MUSEUM. One of Dr. Squires' special interests is the zoogeography of modern deep-sea corals, with particular emphasis on those of the Southern Hemisphere.

The stunning colors on the wings of butterflies and moths are the subject of DR. ALEXANDER B. KLOTS's article, "On the Character of Color." Dr. Klots, Professor of Biology at The City College of New York, is also Research Associate in the Department of Entomology at THE AMERICAN MUSEUM, with which he has been affiliated since 1917. His field work, primarily on Lepidoptera, has taken him all over North America, and to the Antilles, South America, West Africa, and Europe. Dr. Klots has written several books about butterflies and moths, insects in general, and deserts. The remarkable pictures were made by Mr. Kjell B. Sandved, who has photographed thousands of specimens in past years.

MR. DOUGLAS NEWTON, author of the article about Kafir funerary figures, is Curator of The Museum of Primitive Art, in New York City. Mr. Newton, who has worked in London as a writer and designer, wrote the book *Art Styles of the Papuan Gulf.*

The description and photographs of cuckoo behavior that appear on pages 48-51 are the work of MR. KÁROLY KOFFÁN, who is known in his native Hungary as a painter, graphic artist, and photographer. The pictures and text were excerpted from Mr. Koffán's book *Birds in Camera,* which was published in London by Barrie and Rockliff.

DR. MARION WHITNEY, whose article explains the bizarre appearance of twisted trees on the Texas coast, teaches biology at Central Michigan University. She has three degrees in geology and botany, and her interests range from structural geology to animal behavior.

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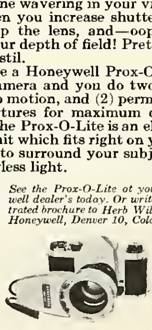

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WASHINGTON NEWSLETTER

By Paul Mason Tilden

The Green River Fiasco

Against a background of the yet smoldering pages of *Silent Spring*, the words "pesticide" and "poison" have been largely dropped from the corridor chats and endless official conferences that are integral to the daily routine in Washington. Omission of the words has been especially marked in agencies that, for purposes of their work in the field, continue to make use of pesticides and poisons—ordinarily for purposes both legitimate and well controlled.

It is not the intention of this newsletter to reopen a debate of the merits or demerits of Miss Carson's explosive volume. It must be pointed out, however, that were the lady in need of further ammunition for her cannonading against the reckless use of poisons as biological controls, the recent Green River fish-poisoning program—a joint venture of the Department of the Interior's Fish and Wildlife Service and the states of Wyoming and Utah—was well calculated to supply an ample quantity of new rounds for her guns.

The Green River is one of the major tributaries of the great Colorado. Rising on the west slope of the Continental Divide in Wyoming, it snakes its way south through that state into the colorful wilderness of northwestern Utah, bends briefly eastward into Colorado, then it returns to Utah to flow south toward a confluence with the Colorado in the little-known canyon lands of southeastern and southern Utah.

As a part of the huge Upper Colorado River Storage Project, the Ashley Dam in Utah, a few miles south of the Wyoming border on the Green River, is now beginning to build up the waters that will form the Flaming Gorge Reservoir. The reservoir will reach from the dam construction town of Dutch John, Utah, almost to Green River, Wyoming, some ninety-one miles to the north.

Before closure of the dam, it seemed to the Wyoming and Utah fish and game commissions—and to the U.S. Fish and Wildlife Service—a good idea to clean out a long reach of the Green River above the Ashley Dam with rotenone, a fish toxicant, and eliminate native "trash fishes," that is, any species not considered desirable by sport fishermen. After closure of the dam, the full reservoir was to be stocked with exotics like rainbow trout and a species of salmon. The rotenone, said the managers, could be neutralized below the Ashley Dam with doses of the detoxicant chemical potassium permanganate.

Over the protests of many prominent American biologists (and shamefully few conservationists) who foresaw the makings of a disaster not only to endemic fishes but to the river's aquatic insects, its important zooplankton, and its water-dwelling invertebrates, some 22,000 gallons of an emulsified rotenone preparation were introduced into a long reach of the Green and its tributaries above Ashley Dam during early September, 1962, by the agencies involved.

The worst fears of the biologists were realized. Down through the Ashley damsite coursed the rotenone; the potassium permanganate (whose detoxifying effects in a river the size of the Green were unknown) was introduced too late, in too little amount, or both. The Green River and its tributaries were turned into 475 miles of biological near desert, including that portion of the river that flows through the National Park Service's Dinosaur National Monument astride the Utah-Colorado border—dedicated by law as a scenic and scientific preserve, and supposedly inviolable.

Gone with the rotenone were the "trash fish," to be sure, along with much of the rest of the river's biota. Included among the casualties were four rare

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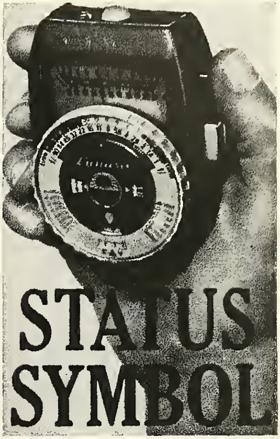
Mr. Tilden, who is a writer and editor with his base in Washington, regularly contributes close observations of the capital's activity to Natural History.



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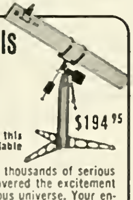

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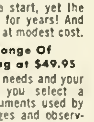

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American fishes for which the poisoned portion of the Green River was prime habitat. These are known locally as the Colorado squawfish, largest of Western Hemisphere minnows, specimens of which have attained weights of up to one hundred pounds and lengths of up to six feet, the humpback chub, the humpback sucker, highly specialized for life in the rushing waters of the Green; and the fast-water form of the bluehead sucker. For what, the reader may wonder, was this biological destruction wrought? The answer: a minimum goal of six years of good trout fishing in the Flaming Gorge Reservoir, according to fish managers.

Since the Green River fiasco, scientists and conservationists have expressed the opinion that this was too high a price to pay for good trout fishing, for six, or any other number of years.

Wedding on the Potomac

EARLY this February there were cakes of dirty ice moving slowly past Washington down the Potomac toward Chesapeake Bay. Cherry blossom time was still two months or more away; a few grimy patches of snow and lumps of black ice lay sullen and seemingly imperishable on the sunless sides of the monolithic Interior and Agriculture buildings, north and south of the city's famous Mall. As unpropitious as the weather was, the Departments of Interior and Agriculture were headed to the altar for a February wedding.

Conservationists felt that it was not a case of love at first sight between the two land administration agencies. Bride and bridegroom were led up the aisle, gently but firmly, and given away by the President's Cabinet-level Recreation Advisory Council, after fifty-odd years of mutual sniping, undercover warfare, and watchful jealousy.

The news spread rapidly through the conservation world. Optimists, told that Interior and Agriculture had buried the hatchet, exclaimed: "Wonderful!" Pessimists, given the same information, were inclined to ask, "Whose head was it buried in?" The President characterized the agreement as a "milestone in conservation progress"; if the past's ill-concealed differences between these two departments are to be permanently laid to rest, the President's statement would seem overmodest.

Specifically, the treaty concentrated on Interior's National Park Service and Agriculture's Forest Service. It provided for:

1. Mutual recognition between the two departments of the distinctive administrative functions and land management plans used by the Forest Service and the Park Service in administering lands under their jurisdictions;

2. Unaltered jurisdictional responsi-

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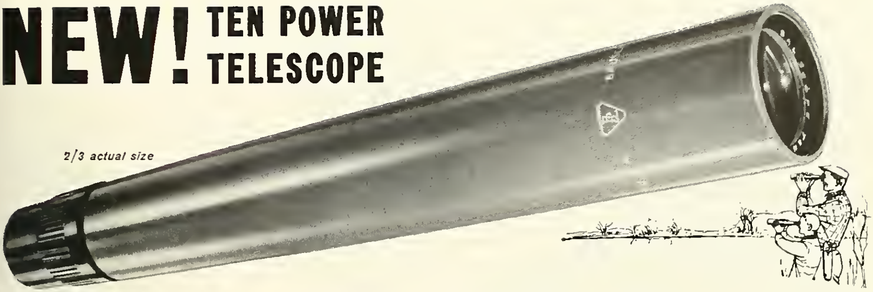

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bility of agencies of the two departments that are managing and developing lands for public recreations, except for existing administration proposals;

3. An arrangement whereby neither department can initiate, unilaterally, new proposals to change the status of lands under jurisdiction of the other department and that independent studies by one department of lands administered by the other will not be carried on. (Note: it was such an "independent study" by the Park Service of Forest Service lands in Washington's northern Cascade Range several years ago that brought interservice ill will to a white heat. The study concerned the possible establishment of a great new national park in the Cascade Range.)

4. The full and effective development and management of the recreation lands now under the jurisdiction of each department, with support and co-operation of the other.

Whatever the long-range meaning of the new agreement—if it indeed becomes "long-range"—the immediate prospects for two great new national recreational areas and another national seashore have been brightened immeasurably. Both Agriculture and Interior will, as an immediate result of the amnesty, recommend legislation to Congress establishing the Whiskeytown-Shasta-Trinity National Recreation Area, of some 280,000 acres in north central California; the Flaming Gorge National Recreation Area, of about 160,000 acres in Utah and Wyoming on the Green River above the Ashley Dam in Utah; and an Oregon Dunes National Seashore (long advocated by preservationists), of 35,000 acres on the central Oregon coast. The first two areas would be administered jointly by the Park and Forest Services, and Oregon Dunes solely by the Park Service.

In addition, the Secretaries of Interior and Agriculture have *jointly* appointed a five-man team to study the outdoor recreation possibilities of the northern

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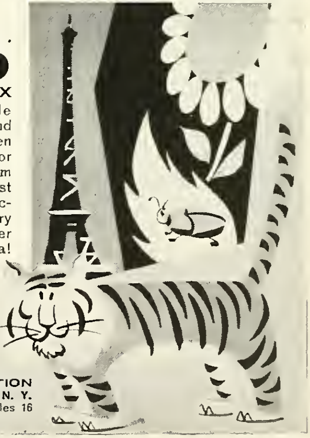

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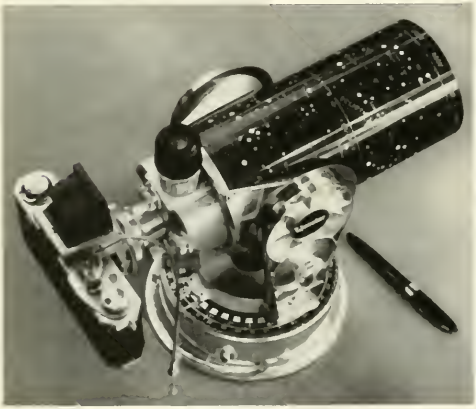
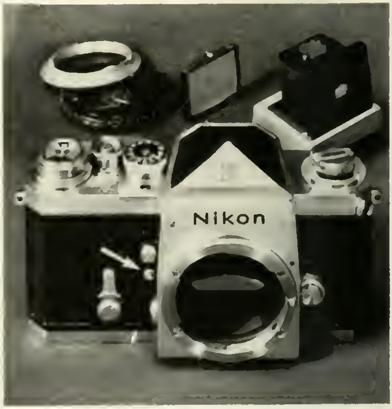
Cascade Range—a move that would have been considered fantastic prior to February's cold marriage on the Potomac.

In The National Parks

During the past several years the National Park Service, in the Interior establishment, has been under considerable pressure from a small number of state fish and game commissioners and some (but by no means all) sportsmen's groups, to throw open the great parks and monuments to hunting. The argument of those favoring public hunting in the parks has largely revolved around the need for management of the so-called northern Yellowstone elk herd. In years past, because of its protection, plus the elimination by man of natural predators, the herd has outstripped the carrying capacity of its winter range in Yellowstone Park, to the detriment of both the elk and other animals that inhabit the preservation.

The Park Service's field personnel has made great efforts to cope with the problem of ungulate mammal overpopulation, in Yellowstone and in a number of other parks where the problem exists, and has reduced that problem to one of relatively minor significance. Despite progress, however, pressure for public





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Sharp focus has always been a problem with long-focus telescopes. With camera close-coupled, Questar works at f/16 at 36 inches. With 2-inch extension tubes to reduce vignetting, f/18 at 64 inches. These focal ratios give such dim views that the image is hard to see. The standard split-prism rangefinder works only with fast, low f numbers. But Nikon's Type C interchangeable groundglass, with clear center and hairline cross, at $17.50, gives brilliant images with a mark to keep the eye from accommodating in front or behind the focal plane. At right is the waist level finder, $22.50, which permits best view of the Type C cross with eye up close to its lens.

The new cadmium sulphide light meters, with their small openings, have been used by Questar owners to apply directly to visual eyepiece or camera views of the image. If we can measure the actual amount of light that will hit the film, we will eliminate that host of variable factors which has made the computing of exposure tables impractical for telescopic work. What we seek is the exact shutter speed. This system holds great promise, and we shall publish data on it as soon as we can.

At upper left is a new, more compact ring adapter, $10.00, to secure Nikon F bodies to Questar's $23.50 basic camera coupling outfit, a multi-purpose device described in detail on page 26 of the Questar booklet. Questars still cost only $995, or $1100 with quartz mirror for best thermal stability. Each is a gem of superfine optics, whose sharpness may eventually be equalled, but will not often be surpassed.

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hunting has been sufficiently strong to constitute a challenge to the principles that have governed the management of the national parks of the nation for nearly a century, both by law and custom. Public hunting in major national preservations has been fallaciously pictured by interested groups as a valuable contribution to the Park Service in its animal population control work in parks. even. indeed. as a patriotic act on the part of would-be participants.

In response to the pressure, Secretary of the Interior Stewart L. Udall, who is ultimately responsible for implementation of Park Service policy, appointed, in 1962, an advisory board of distinguished citizens to study the problem of wildlife management in the parks and to report its conclusions to him. Members of the board included: Dr. A. Starker Leopold, Assistant to the Chancellor of the University of California at Berkeley, chairman; Dr. Ira N. Gabrielson, onetime chief of the U.S. Fish and Wildlife Service, now President of the Wildlife Management Institute, in Washington; Dr. Clarence Cottam, widely known biologist and President of the Welder Wildlife Foundation in Texas; Dr. Stanley A. Cain, Chairman of the University of Michigan's Department of Conservation; and Thomas L. Kimball, Executive Director of the powerful National Wildlife Federation.

During the spring of 1963, the Secretary's advisory group brought in its report. It said in essence: public hunting has no part to play now or in the future in the management of elk or any other animal populations in national parks and monuments. The Leopold report, said the Secretary, would "serve as a guide to this Department and the National Park Service through the years ahead."

(Persons actively interested in the preservation facet of the general conservation field may secure a free copy of the Leopold report, *Wildlife Management in the National Parks*, from the National Park Service, Department of the Interior, Washington 25, D.C.)

Wildlife Protective Measures

ONE of the animals historically associated with the taming of the American West was the so-called wild horse—perhaps a descendant of the Spanish mustang of an earlier period—which at one time roamed the arid lands of the West by the hundreds of thousands. The coming of "civilization," with its attendant train of domestic livestock, made deep inroads into the natural habitat of the wild horse, which competed with

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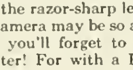

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man's animals for available forage. Starvation, disease, and roundups by both Indian and white man all played parts in reducing wild horse populations. In modern times, the airplane has been employed to round up remnants of the herds for slaughter as pet food.

A federal law was passed in 1959 forbidding the use of airplanes and motor vehicles in wild horse roundups on federal lands; but since the law had no effect on state-owned lands, the slaughter was often continued. Today the number of wild horses on western ranges has been estimated in the neighborhood of 15,000 head; these relative few that remain still compete with domestic animals for grazing space.

To preserve at least a representative band of the colorful mammals, the Bureau of Reclamation, in the Interior Department, has recently worked out a plan with the Air Force and the state of Nevada to set aside a 435,000-acre portion of huge Nellis Air Force Base, in southern Nevada, as a refuge for the wild horse. While the range will support only a few hundreds of the animals it will, in the words of Interior Secretary Udall, "assure those of us who admire the wild horse that there will always be some of these animals." Outside of the refuge, the Secretary pointed out, wild horses will probably remain a source of local and regional controversy.

Recently launched by the Bureau of Land Management is a project to bring the masked bobwhite quail back to the southwestern United States, and perhaps they will eventually become part of the natural scene. For years this bird was listed as one of the many animals that had passed into extinction, but a few specimens have been located in the State of Sonora, Mexico. Three pairs were recently brought from Sonora to the United States, where they were released on a posted 640-acre Bureau preserve adjacent to Arizona-Sonora Desert Museum lands near Tucson, Arizona. Conservationists hope that the initial group will prosper and eventually attain numbers sufficient to insure perpetuation into the indefinite future. The masked bobwhite quail project is being supervised by the Desert Museum with co-operation from the Bureau of Land Management, the Arizona State Game and Fish Department, and the Allegheny Foundation of Pittsburgh.

This list details the photographers, artist, or other source of illustrations, by page.

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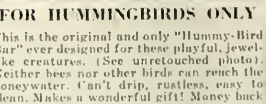

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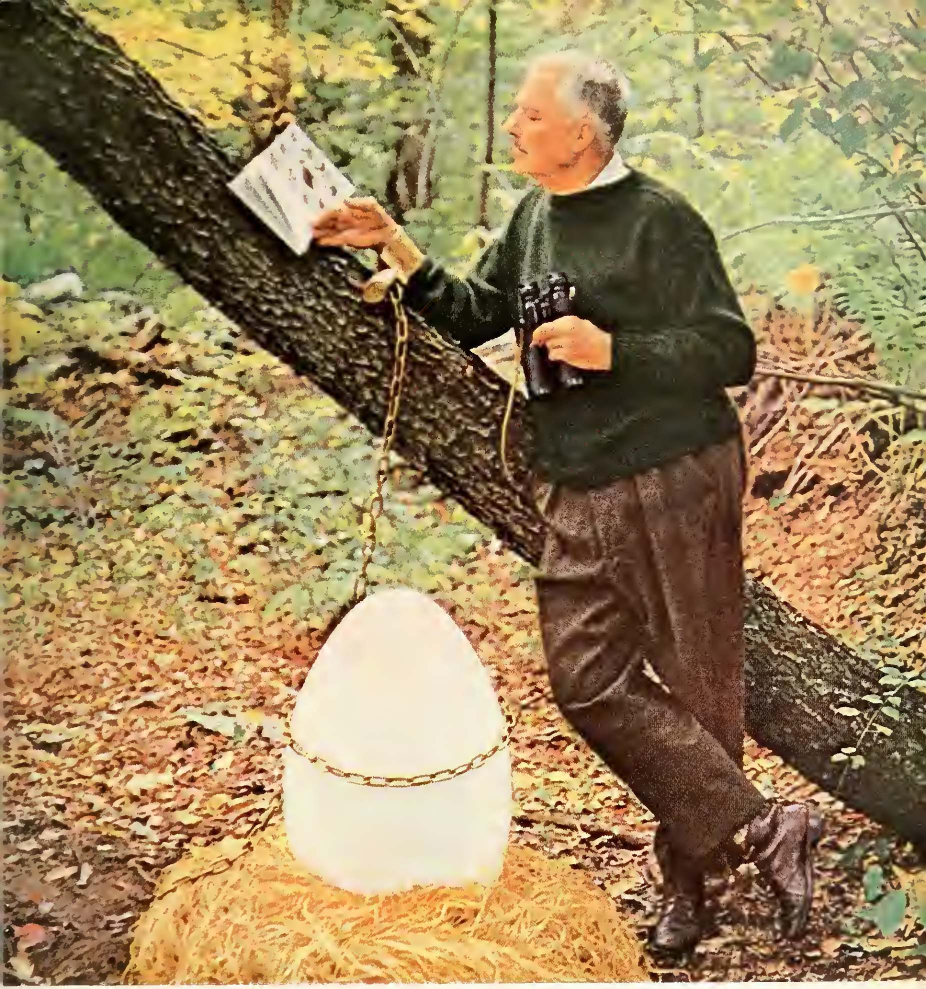

In pursuit of the pileated woodpecker—Mark Shaw photo

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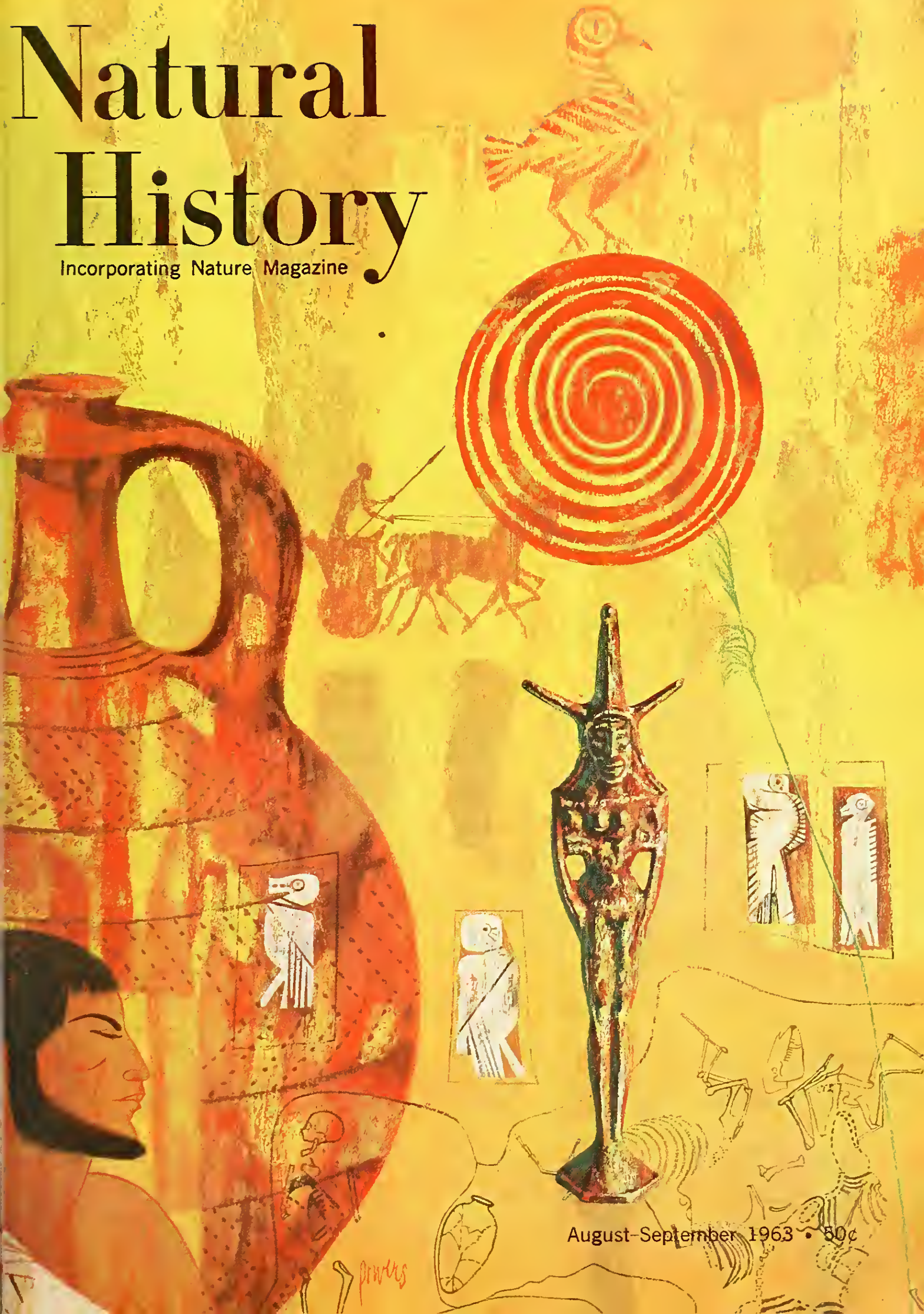

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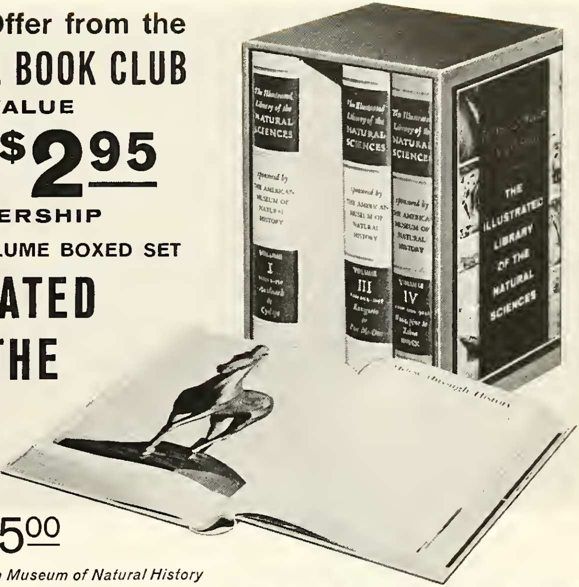
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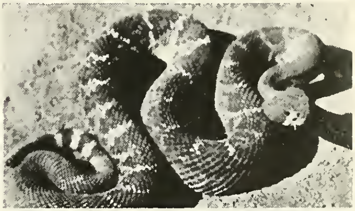

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Vol. LXXII AUGUST-SEPTEMBER 1963 No. 7

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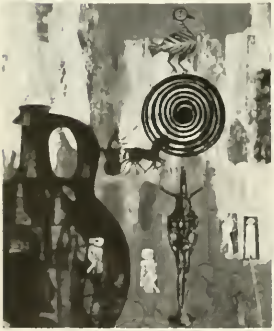

COVER: The Hyksos, a heterogeneous people of obscure origins, were—about 3,600 years ago—the rulers of Palestine and Egypt. Among the various elements in the Hyksos potpourri painted for NATURAL HISTORY's cover by Richard M. Powers are: a typical Hyksos jug; a spiral found frequently in Hyksos designs; a two-wheeled war chariot, which the Hyksos are believed to have introduced to Palestine and Egypt; a cast statuette of Astarte; and a floor plan of a burial site containing equine and human bones. More representations of Hyksos artifacts accompany "Rulers in the East," by Dr. Emmanuel Anati, beginning on page 18.

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Publication Office. The American Museum of Natural History, Central Park West at 79th Street, New York 24, N. Y. Published monthly, October through May; bimonthly June to September. Subscription Price, $5.00 a year. In Canada, and all other countries: $5.50 a year. Single copies: $.50. Second class postage paid at New York, N. Y., and at additional offices. Copyright, 1963, by The American Museum of Natural History. No part of this periodical may be reproduced without the written consent of NATURAL HISTORY. The title NATURE MAGAZINE, registered U.S. Patent Office. Unsolicited manuscripts and illustrations submitted to the editorial office will be handled with all possible care, but we cannot assume responsibility for their safety. The opinions expressed by authors are their own and do not necessarily reflect The American Museum's policy.

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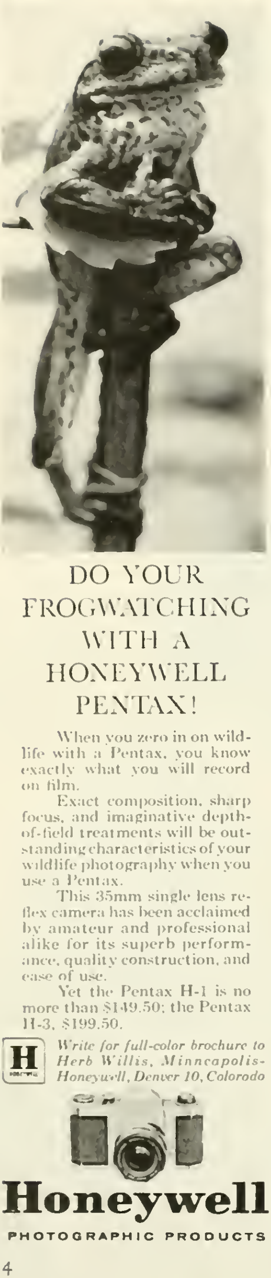

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Reviews

Celestial science as an extension of man

By Thomas D. Nicholson

ASTRONOMY OF THE 20TH CENTURY, by Otto Struve and Velta Zebergs. *The Macmillan Co., $12.50, 544 pp., illus.* ASTRONOMY, by Fred Hoyle *Doubleday & Co., $12.95, 320 pp., illus.*

It is probably no accident that the most significant popular writings in astronomy have been produced by the most competent scientists and scholars in the field. Certainly this is true of the many popular and semipopular periodical articles, reviews, and books written by Dr. Otto Struve, the senior author of *Astronomy of the 20th Century*. No astronomer in our times has contributed more in quantity and quality to the general understanding of his science than he. At the same time he was, for decades, one of the outstanding scientists, teachers, and administrators in astronomy. Thus his death at the age of 66, on April 6, 1963, was a great loss to the science he loved, to the nation he adopted—the United States—and to the public at large.

Most of Dr. Struve's work was in stellar spectroscopy. He was especially respected for his observational and theoretical investigations of the rotation of stars, interstellar material, peculiar stellar spectra, spectroscopic binary stars, and stellar evolution. His contributions to astronomy earned him many awards, including honorary doctorates from nine American and foreign universities, the Gold Medal of the Royal Astronomical Society of London, the Draper Medal of the National Academy of Sciences, and the Bruce Gold Medal of the Astronomical Society of the Pacific.

Astronomy of the 20th Century is organized around a number of special subjects within the broad field of astronomy. The foundation for the book is set forth in the first two chapters, in which the authors review the factors of current history that have contributed to the development of astronomy and describe the state of the science as it existed in 1900. Four observational techniques are then described in a chapter for each—astronomical photography, spectrographic measurements of radial velocities, photometry, and radio astronomy. Each of these techniques has been of great importance in many areas of astronomy in recent years. The remainder of the book presents fourteen special subjects that the authors have chosen as the outline for their story, each subject in a separate chapter. These are: the sun, physics of the solar system, origin of the solar system, spectral classification of the stars, stellar atmospheres stellar structure, stellar evolution, double stars, variable stars, explosive variable stars, interstellar matter, galactic nebulae, the Milky Way, and exterior galaxies. In each of the chapters, the authors briefly trace the historical outline of the subject up to the twentieth century, then describe the important events instruments, and investigations that have contributed to our present knowledge o the subject and the investigators whose work has most influenced the field. I the appendix, the authors have included an excellent review of the history and principles of stellar spectroscopy, a glossary of nearly two hundred words, and a bibliography identifying the principa journals and books that were used i the book's preparation.

There is no book comparable to *Astronomy of the 20th Century*. The growth of astronomy in recent decades has been so remarkable that many authors hav either chosen to ignore the historica perspectives in the current century or in treating this period, have lost sigh of the fact that astronomy is still bein made by people. Struve and Zebergs have, however, conveyed to the reader sense of the personal conflicts and contributions that are continually presen in astronomy, and have shown where th influence of personalities of our time has given direction to the science. The have shown convincingly that our knowledge of the universe is a very human creation, that it has evolved slowly, bu always toward a picture that more accurately represents nature. But the picture is not yet complete by any means. Jus as it has changed in the past, it will continue to change in the future. Readers o *Astronomy of the 20th Century* may b surprised at how recent some of our idea concerning the universe really are, an after having finished the book they wil be better prepared to accept and understand the changing concepts that futur investigations will suggest.

Very few faults can be found with this book, and those few are minor. Th material on galaxies could have been more extensive. The footnote definition of some elementary astronomical term could have been left out, although I suppose that some editor insisted upon them to broaden the potential market. Still, I don't see how anyone could get far in this book if he needed some of the explanations that are included. Finally, the illustrations, especially the line figures, could have more complete legends. Many are further described in the text, but not always on the same page as the figure and often without a clear reference to the figure. But these are, as I said, minor, and will not detract in any way from the value of the book for most readers.

In *Astronomy* another noted astronomer, Professor Fred Hoyle, traces the history of the science from its beginnings in ancient Babylonia and Greece to the current century as a framework for a description of modern astronomy. In separate chapters, he describes the ancient attempts to solve the riddle of planetary motion, the revolutionary period from Copernicus to Kepler, the contributions of Isaac Newton, and the rapid pace of discovery and theory in the eighteenth and nineteenth centuries. Although these are traditional subjects in astronomical history, Hoyle writes about them in a far from traditional manner, as most anyone will recognize in the author's sympathetic treatment of Copernicus. In addition to the above, separate chapters are given to the history and development of astronomical instruments and to the nature of light. Finally, the author describes modern astronomy in the last four chapters, which comprise about one-third of the book. A good deal of descriptive astronomy is also woven into the earlier chapters on astronomical history.

Fred Hoyle is well known for his skill in explaining astronomy in clever and interesting ways, and many passages in the book attest to his ability. There are places, however, where verbal examples and analogies are carried so far that the reader can lose sight of the point of the lesson. Such is the case in chapter one, where the author surely could have introduced the correct names of the celestial co-ordinate systems much sooner than he did and saved the continual references to them as Case 1, Case 2, Case 3, and Case 4. As it is, even a knowledgeable reader must refer too often to the figures to be sure what the cases mean. Also, in chapter five, the six pages of text in which the author manipulates terms in the laws of motion give the impression of being either a mental exercise for the reader or a sort of window dressing to justify the illustrations on these pages. On the other hand, the descriptions of astronomical instruments and their uses, in chapter two, are excellent, and the analogies between water waves and certain phenomena of light are cleverly written.

Astronomy is beautifully and richly illustrated in black and white and color. The color plates include photographs of astronomical subjects, pertinent art, portraits, astronomical instruments, and pages from historical astronomical manuscripts. Some of the latter illustrations are most interesting, if the reader takes the trouble to examine them closely. Many other astronomical photographs and other subjects are reproduced in black and white and in tones. In addition, a great many original line drawings and sketches, pertaining specifically to the text, have been included. The legends on the photographs and sketches are exceptionally complete and are highly informative.

Although the profusion of illustrations adds considerably to the attractiveness of *Astronomy*, it does not always add to its effectiveness as a history of astronomy or as a book on descriptive astronomy. The author states in his foreword that the illustrations are intended to supplement the text and are not just a means of making the book look good. This did not seem true of three full pages of illustrations related to nova phenomena (the relationship being pointedly made in the legends), when the subject is relegated to four sentences in the text, and then only to illustrate the point that some stars occupy a peculiar position in the color-luminosity diagram.

Nevertheless, the illustrations are attractive, even though the reproduction of some of the astronomical photographs, both black and white and color, should have been better. Great care was obviously taken in selecting the illustrations, and the results are generally good. The same is not true of the printing in the book. I do not know enough about the technical aspects of book manufacture to be sure what, if anything, went wrong. But I do know that the type appears too small, varies in density from page to page, and on some pages seems to be out of focus (although I do not know how this is possible). The result, on some pages, is a print that is tiring to read.

In his foreword, the author acknowledges the assistance of colleagues in the preparation of the book, presumably those persons who are named on the copyright page. This may account for some of the errors that I found in the illustrations and in the text, errors that a man of Fred Hoyle's stature and knowledge surely would recognize and correct were he aware of them. For example, the beautiful Lund Observatory map of the Milky Way is incorrectly called a "panoramic photographic map," as though it were a photographic mosaic. Also, three photographs of galaxies in color have been reversed from the originals. In the text, an incorrect definition of "synodic year" is given; the ten-day error in the Julian calendar dated, not from its in-

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ception, but from the Council of Nicea, about A.D. 325, the word "rotate" should not be used for "revolve" in a legend referring to variable stars; and in one place there seems to be a confusion between three degrees of longitude and three degrees of azimuth.

Popular writing in astronomy is usually at its best when done by persons such as Struve, Zebergs, and Hoyle, for they can draw on the full resources of their profession, are excellent teachers and writers, and have earned the respect of their profession and of the reading public for their work and their past writing efforts. They exemplify perfectly the concern of their colleagues that their science be well presented to the public. This concern was recognized by the American Astronomical Society in a resolution passed by its Council in 1955, stating in part that "a definite need exists for the dissemination to the public at large of accurate astronomical information, consistent with the dignity of the science," and recommending to its members that "astronomers devote reasonable effort to the preparation of . . . nontechnical articles and lectures on astronomy and closely allied scientific topics."

Otto Struve was foremost among the astronomers who carried out that recommendation, and he will be very difficult to replace. Fred Hoyle has also been effective in doing so in many of his past works, and his current book is, in most respects, another fine example of his teaching and writing skill. But scientists such as Hoyle must be extremely careful in supervising the production of their books, because of where they stand between their profession and the public. If they allow too much responsibility to pass into the hands of colleagues in the publishing field, as Professor Hoyle may have done in *Astronomy*, then the real advantage of having science writing done by scientists is in danger of being lost.

Dr. Nicholson of The American Museum-Hayden Planetarium, holds posts as Assistant Chairman and as Astronomer.

OCEANIC SCULPTURE, by Carl A. Schmitz; photographs by F. L. Kenett. *New York Graphic Society, $8.95; 80 pp., illus.*

IN the last century and a half there has been a general increase in appreciation of the exotic arts, but those of the Pacific have so far been the poor relations. Publishers have done very well recently by the ancient cultures in the way of lavishly illustrated books. In particular, there have been a few gorgeous items on Africa; but since Hewicker and Tischner's *Oceanic Art* eight years ago, *Oceanic Sculpture* is the first of its kind—a volume based on large-scale plates of carefully selected objects.

I mention the older book for several reasons. In spite of its comprehensive title, this new book is actually limited to works from Melanesia, and half the objects are from New Guinea. A quarter of the thirty-two plates in *Oceanic Sculpture* repeat subjects in the Tischner-Hewicker volume, and F. L. Kenett demonstrates an astonishingly high level of photography. The quality of the printing is fully worthy of these masterly pictures.

However, it is unfortunate that, given the quality of the rest of the book's production, the publishers saw fit to finish it off by the "perfect binding" method, which has become something of a joke because of its flimsiness. A few of the subjects are not worthy of such magnificent photographic treatment, particularly the famous but mechanical and grotesque Sepik River drum, and the run-of-the-mill ancestral board from the Gulf of Papua. The Sepik house mask is upside down (it is almost traditional for books on primitive art to have at least one picture the wrong way up). But there is also a high proportion of genuine masterpieces, such as the Sepik debating stools and the New Britain double mask.

Oceanic Sculpture is not simply a spectacular treat, however. The long introductory essay by Carl A. Schmitz is a great deal more than a mere accompaniment to the photographs. For many, indeed, it will be the more significant contribution, as it is the first statement in English of his historical theories (apart from the summary in his *Historische Probleme in Nordöst-Neuguinea*). As such, it has a marked importance of its own. In his earlier work Schmitz, Curator of the Basel Museum für Völkerkunde, analyzed a historical sequence of three cultures, which he designated A, B, and C, from the standpoint of present-day conditions and components. It was an impressive achievement, and the first real attempt to take an all-inclusive view of the evidence. In his newest essay he describes in some detail the constitution of his culture B, with its wealth of myth and ritual, a rich source of art.

An objection that can be raised is that, for the unprepared reader, the account is too idealized, for the book gives the impression that considerable uniformity prevailed throughout Melanesian societies. The actual state of these societies was one of great diversity; in local practice, of course, certain traits were stressed or exaggerated while others were neglected or omitted. And if this caution must be issued regarding the author's synthesis of the material culture, it applies even more to his statements about primal myths of the "cosmic parents" and the "cannibal giant." But with these reservations on the table, the fact remains that the essay establishes order where considerable confusion prevailed before, and assisted by the plates, the ook should satisfy the scientific require- ents of aesthetes and the aesthetic stes of scientists.

DOUGLAS NEWTON

HE DESERT WORLD, by Alonzo W. ond. *Thomas Nelson & Sons, $6.50; 2 pp., illus.* BECKONING DESERT, by Ed- ard Maddin Ainsworth. *Prentice-Hall, .95; 264 pp., illus.*

THE author of the first of these volumes writes from decades of per- nal experience in deserts of both Old d New Worlds. All of the book's enty-one chapters deal with subjects lling within the broad scope of natural story. Chapters on such subjects as mes, weather, and climate apply to all sert regions, whereas others—"Nobody ves a Camel" and "Veiled Men of the hara," for example—are more special- ed in scope but are also interesting.

A large part of the book is devoted people of the desert, and this part s, indeed, is the remainder) is liber- ly supplied with personal anecdotes at enhance the readability. If we ex- pt specialized chapters on camels and lm trees, the animals and plants of the sert are given rather short shrift—one apter each. Several general and spe- fic statements on desert animals are in- rrect or misleading. It may be that in e most extreme deserts "all species are re," but this certainly is not true in e American Southwest. In a more ecific vein, the statement that rattle- akes "cannot get along without water . so if you go to a desert water hole night take a flashlight" is based on a lse premise, and persons camped far om water may be lulled into a false nse of security. But I quite agree with e author in minimizing the danger at venomous desert animals present to ople in normal circumstances.

The book is illustrated with two maps d forty black-and-white photographs. any of the latter have a snapshot ality to them; I find this a pleasant ntrast to the current fad of gaudy pic- re books in which the illustrations mpete with, rather than complement, e author's textual accounts.

Whereas the shortcomings of Pond's ok are more than balanced by its in- resting and valuable material on ysical and cultural aspects of deserts, *ckoning Desert* does not fare so well. re, too, only a small part of the book, ich emphasizes the California desert, als specifically with biology, but here e errors are too numerous to be over- oked. Some, as the use of "French- oted" for "fringe-footed" lizard are using. On the other hand, the author scusses the study of thermo-regulation reptiles, which leads to the conclu- n: "If enough can be learned about an's possible adaptation of some of the lizard's thermal habits, air-conditioning may be made much simpler, and, in fact, we may some day take an air-conditioning pill." Such a statement reveals that the author has little understanding of his subject.

Readers who are interested in local history of the desert region of California and who can recognize and discount the errors of biology may find some material of value here. A distraction for this reviewer is a style of writing that features paragraphs of one sentence or less. My two favorites are, "Thank you, mighty Goddess Flora, for your good gifts to us in the land of little water" and "Bullfrogs!"

RICHARD G. ZWEIFEL

THE KIOWAS, by Mildred P. Mayhall. *University of Oklahoma Press, $5.95; 315 pp., illus.*

MOST of this book is devoted to frontier history as reported by various explorers, soldiers, and traders and is likely to be of interest only to the most confirmed Plains Indian enthusiasts. Since most of the reports are trivial and subjective, the chapters on history are tedious, and sections concerning Kiowa ethnohistory suffer from a lack of selection and summary. (A thirty-seven page chapter gives, year by year, the events recorded in two of the annual calendars of the Kiowa—small paintings on buffalo hides. As Mayhall notes, most of the events are of little consequence. The entry for the summer of 1855 is fairly typical: "The pictograph shows a seated man. It was a hot summer with no Sun Dance and no grass. The horses were too weak to travel, and the Kiowas 'sat down.' ") Miss Mayhall's description of Kiowa ethnography covers only forty-six pages, and this is also disappointing, for one would expect a more extensive treatment in a book entitled *The Kiowas.* Many important subjects, such as hunting and leatherwork, receive but a single paragraph of discussion.

The author's handling of basic anthropological concepts and some of her historical interpretations are particularly misleading. The culture area concept is poorly explained and her account of the formation of the distinctive Plains Indian culture is a poor derivation from the anthropology of the 1920's. The horse was important in Plains culture, as she states, but to describe the Plains Indian as having a "centaur personality" goes too far. Personality traits characteristic of the Plains occurred over most of the eastern United States. With regard to the effective death of Plains Indian culture in the late nineteenth century, Miss Mayhall places primary responsibility on the Indians: "Within it [Plains culture] were the seeds of its own deterioration: its predatory characteristics were anti-

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social and vicious—against other Indians as well as against the whites." She knows better. Massive American military power, extermination of the buffalo, and an increasing number of settlers ended Plains Indian culture. We may have a collective guilty conscience about the Indians, but we ought not to write histories to ease it.

Stanley A. Freed

The Life of Birds, by Joel Carl Welty. *Alfred A. Knopf, $12.95; 546 pp., illus.*

Beloit College achieved fame, insofar as The American Museum of Natural History is concerned, years ago when Roy Chapman Andrews left its cloistered halls and headed for New York. Now Professor Welty, another comparative unknown—at least in professional ornithological circles—from that institution has written the best general reference book on birds to appear recently in this country. The coverage is broad, the treatment and arrangement logical and balanced, the approach modern. *The Life of Birds* is a big volume illustrated with numerous drawings and carefully selected photographs, and it concludes with a well-selected list of valuable references.

Naturally, in a work of 250,000 or so words, closely packed with facts, one can find a few interpretations with which to argue. The Ascension Island Man-o'-war bird, for example, is said to have lost the ability to extend its range because of the small size of its oil gland, which prevents it from oiling and waterproofing its plumage. It is implied that this misfortune occurred after the bird reached Ascension. There are, however, Man-o'-war birds on suitable tropical islands around the globe, some of them so similar that they may belong to the same species. Furthermore, the waterproofing deficiency, if such it is, is probably a characteristic not only of all Man-o'-war birds but even of their relatives such as cormorants, which are often seen drying their feathers. Nevertheless, cormorants are found on many scattered, cold islands. Or again we are told that "changes in diet may also be forced by periods of inclement weather.... Hobbies, *Falco subbuteo*, will eat larger numbers of swifts in cold wet weather than in fair weather," (because the swifts are weakened by a scarcity of flying insects). More, rather than fewer, swifts does not necessarily constitute a change in diet, and in any case it is not forced! Incidentally, neither this Man-o'-war bird nor the Hobby is mentioned in the rathe skimpy index that is provided.

Such dubious inferences seem to decidedly rare in this book. As implie above, I consider it the best readily avai able work on birds either for the layma or for use as a college text — althoug for the latter purpose a supplementar laboratory manual would be necessar

Dean Amado

Under the Mountain Wall, by Pete Matthiessen. *The Viking Press*, $7.50 *256 pp., illus.*

Peter Matthiessen has given us curious book. Without being able recommend it to everyone as a book sit down and read, I can recommend most highly as a book to pick up and look at, here and there, for a few moments. There will be moments of plea ure and excitement that, despite the publisher, afford an all too brief but intimat insight into the mystery that is man.

Ostensibly this is about the lives an wars — particularly the wars — of a ston age people in New Guinea. However, th reader is put off by what seems to be willful caprice of the publishers.

The end papers are perfectly respec able. They tell you where the scene set, in a valley in New Guinea, and all looks very homey, with trees, hut and fields — and discreet use of the symbol of the skull to indicate a "site human bones," whatever that is. The comes a rather fine title page, which followed by "Contents," and here w should pause. There are sixteen lines print, and you hopefully try to disco what the book is about. But fifteen the sixteen lines refer to the end paper lists of illustrations, photographic se tions, credits, and so on. The one exce tion simply repeats the title of the boo and gives the page numbers betwe which it falls (1-256), as though th text were quite incidental to the illu trations and photographic sections th have been selected to surround it.

By the end of the preface, which hel clarify the title of the book to some e tent, you are ready for the text, but her you are faced with another list, this tim of twenty-seven photographs cramme together, often several to a page. The comes text—unchaptered pages printe inexplicably, on a sickly green paper.

Mr. Matthiessen does not set out write a consistent ethnography. H merely describes day-by-day life in th remote valley, with events occurring ju as they do in our lives — inconsequenc mingled with matters of the gravest import. One first watches people one doesn know getting wounded and killed quit needlessly, it seems, but with great zes Then one gradually gets to know thos who remain behind, and when *they* fa victim to their strange passion for wa fare, some of their feelings of life and death as they go to battle are communicated to the reader.

If you are as I am, you will have to contend with near tears at times, and yet it is not a sentimental book. Men, women, and children are killed almost as a matter of course, and it arouses no particular feeling, so the author portrays none, despite what he may have felt at the time. But every now and then emotion *does* creep in, and then it is all the more powerful. It may be the pitiful death of little Weake, who did not want to die, or it may be the gesture of his friend, Tukum the swineherd, who felt alone.

However powerful it is in places, the book is marred by the total presentation, which serves only to separate the reader from the subject matter.

The text is followed by eighty-five more photographs, all compressed into sixteen pages, and when you get seven photographs on one page they lose, for me at any rate, whatever interest they might have had.

Whatever reasons the publishers had for this odd arrangement, other than penny-pinching at the reader's expense, they successfully ruined the effect of what could have been a beautiful book—beautiful both in content and in its visual presentation.

COLIN TURNBULL

THE WILD DANUBE, by Guy Mountfort. *Houghton Mifflin Co., $6.00; 207 pp., illus.*

No substantial corner of Europe is truly wild, in the sense of being undisturbed by man. The notion that the historic and legendary Danube should be considered wild seems especially paradoxical to an American. Yet for the party of Britishers who spent two summers in Bulgaria and Hungary photographing and studying birds, the area doubtless had a comparatively unspoiled and strange quality. (Aspects of these trips were published in NATURAL HISTORY in April, 1961, and May, 1962.) At least one could still find, breeding near the great river, large birds that have ceased to occur in western Europe. Besides, there was the challenge of conducting a photographic expedition behind the Iron Curtain—and this adds piquancy to the tale here told.

Mountfort writes in a pleasant and informal style of the problems surmounted, the adventures experienced, the accomplishments effected. The book is not limited to natural history, although bird study was the chief motivation of the expedition. For instance, the account of red tape in the world of Communist bureaucracy is of much interest. But after all, these trips had the utmost co-operation from the responsible officials, as well as from local ornithologists, in the two countries visited—otherwise the expeditions would never even have been contemplated.

In Bulgaria, the area less known ornithologically, primary objectives had been to photograph nesting pelicans in the Danube marshes, Great Bustards in the arid steppes, and White-tailed Eagles on the Black Sea coast. All these birds were seen and all but the eagle were photographed—but photographing active nests was something else. In the past few years the steppes have been almost completely transformed by large-scale irrigation and planting of shelter belts of *Robinia pseudoacacia* — a fast-growing North American tree. The Danube marshes are being rapidly reclaimed for agriculture, and in the sanctuary, where American muskrats have been introduced, the local fishermen destroyed the pelican nests. The Black Sea coast is now dotted with holiday resorts and towns, reached by motor vehicles, so that the freedom from disturbance demanded by breeding sea eagles is gone. However, a nesting pair of Lesser Spotted Eagles was photographed inland in the Baltata Forest. The Great Bustard was not photographed on its nest until a subsequent year in Hungary.

The book is richly illustrated with photographs, chiefly by Eric Hosking—than whom there is no better bird photographer. Of his numerous bird pictures I particularly like the two of the Great or Common Egret in action (the caption uses the old confusing name "Great White Heron," which even the British Ornithologists' Union Check-list has dropped). But the photographs are not limited to avian subjects; they include other animals, plants, landscapes, historic architecture, ancient gold ware, and people—and they are all very good. Just as the illustrations cover a wide field, so does the narrative.

Mountfort's previous expeditions to the *marismas* of southern Spain (NATURAL HISTORY, October, 1958) and the publicity and interest roused by his book, articles, and by the motion pictures and lectures of his associates, have resulted in the creation of a Spanish preserve. There is reason to hope that in southeastern Europe a similar consequence of the activities described in this book may be the setting aside of needed wildlife sanctuaries and better protection in those that already exist.

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By George B. Schaller

Mountain Gorilla Displays

Chest-beating seems to manifest "fight or flight" tensions

ONE HUNDRED YEARS ago Du Chaillu (1861) first described a ıale gorilla "beating his chest in age." Almost every hunter, traveler, nd scientist who since that time has ncountered gorillas in the wild menions this striking display. in which ıe animal rises on its hind legs and eats a rapid tattoo on the chest with s hands. But it is a curious fact that one of the observers noted that the hest beat is merely the climax of a omplex series of actions. Although ther apes and man share some of the asic display movements, several of s manifestations appear to be species-pecific and lend themselves particurly well to an ethological analysis.

The chest-beating displays consist of nine more or less distinct acts. The whole sequence is given infrequently and then only by silverbacked males, which are fully adult and at least ten years old. It is an extremely impressive display that may require as long as thirty seconds to complete, although all but the first two acts follow each other in one continuous, violent motion, which is usually finished in five seconds or less.

At the start of the display the gorilla may be sitting, lying, or standing on the ground or in a tree. The animal emits a series of soft, clear hoots, which start slowly but grow faster and faster until the individual sounds merge into one another at or near the chest-beating climax. While hooting, the head is characteristically tipped up slightly or, sometimes when sitting, far up like a howling dog; the lips are pursed, and the "hu-hu" is emitted through parted lips. Occasionally a single hoot is given; sometimes five calls follow each other about one second apart. However, a complete display includes a series of some ten to forty distinct hoots that gradually fuse into a slurred growling sound at the climax of the display. One silverbacked male took twenty-two seconds to emit thirty-five distinct hoots.

Apparently males find it difficult to reach the climax if distracted or if the rhythm of their hooting is broken. One silverbacked male, for example, was interrupted by the chest beat of a blackbacked male immediately behind him. (Blackbacked males are from six to ten years old.) The silverbacked male stopped vocalizing, turned and looked, then began to hoot again.

In one group under observation, two or more silverbacked males occasionally vocalized together. One began hooting, only to trail away to nothing before trying again. Then another joined in, and a third. Their clear hu-hu rose and fell as each stopped and started independently. But when one reached the climax and beat his chest, the others followed. Then they usually settled down for a few minutes before repeating the procedure.

Hooting is usually a preliminary to several vigorous actions of the display, and it seems to be recognized as such by the other members of the group. At the first hu-hu the animals near the performer move back. Infants apparently have to learn to avoid a displaying male: the youngest animal that fled the vicinity of a male was about ten months old.

About 5 to 10 per cent of the chest-beating displays by silverbacked males that reach the climax are preceded by "symbolic feeding," which sometimes interrupts the hooting. The gorilla sits or stands, reaches out, and very gently plucks a leaf or herb between thumb and index finger, and places it between his lips. Sometimes it pulls a leaf from the plant with a quick backward jerk of the head, using the lips directly. The leaf, herb, or branch is often held between the lips until or immediately after the chest-beating climax, although occasionally the animal drops the vegetation right after plucking. Once a blackbacked male placed crumbly lichens between his lips with the result that he spit and wiped the material from his mouth for more than one minute after the display.

THE amount of vegetation an animal stuffs into its mouth is highly variable, ranging from a single leaf or twig to several consecutive handfuls of leaves and vines that do not necessarily belong to a food species. When such symbolic feeding occurs, members of the group close to the displaying male seem to recognize the gesture and generally move away from him, thus escaping the subsequent violent parts of the display.

Most gorillas rise up on their hind legs just preceding the chest beat and remain bipedal for several seconds if the intensity of the display is sufficiently high. Although the position of the body is upright, it is not as erect as is usually portrayed in the stuffed specimens of museums. Instead, the legs remain bent at the knees and head and torso are hunched forward.

Gorillas commonly throw vegetation during the display, and the throwing takes several forms: (a) an underhand motion in which the gorilla tears off the vegetation and propels it upward with one continuous swing; (b) a sideways motion in which the animal first tears off a branch or herb and then throws it forward or sideways with the arm either straight or flexed at the elbow; (c) an outward flick of the wrist or lower arm in which the

VIRUNGA VOLCANOES in Albert National Park, E. central Africa, *top*, was site of gorilla study. Blackbacked male in a jungle clearing, *left*, beats his chest.

vegetation is first snapped off and then thrown; (d) a simple dropping of an object in which the animal detaches and releases a branch, usually without propelling it.

OCCASIONALLY gorillas throw with seeming deliberation. First the animal looks around for an herb or branch, detaches it, most often with only a twist of the wrist, but sometimes with considerable effort when a branch is involved, and flings it away, following the flight of the object with its eyes. One male looked intently to one side, then at a branch above him, as if debating whether or not to break it off, but finally rose and beat his chest. Another male lightly pulled at a large branch with one hand as if to test its strength, and then slapped his chest instead.

The climax of the sequence is the chest beat, which is the most frequently heard and seen part of the gorilla's display. The animal characteristically stands on its hind legs, raises the bent arms laterally, and rapidly beats the chest over the lower edge of the *pectoralis major* muscle with open, slightly cupped hands.

Chest-beating can occur in almost any bodily position and the only requisite is that at least one hand is free to do the slapping. The display is seen in animals standing bipedally or on three legs, in sitting ones, and in those lying on their backs or sides. A juvenile even hung from a branch by one arm and beat its chest with the other.

The hands are almost invariably held flat while beating the chest; that is, with fingers extended and the palm often slightly cupped. The animal is inclined to hold its hands within six inches or less from the chest, and the alternate beats are rapid and direct. The fingers are often spread in females and young animals, but those of adult males tend to touch.

The sound produced when a silverbacked or large blackbacked male beats his chest may be described as a hollow "pok-pok-pok," somewhat resembling the noise produced by rapping an empty gourd with sticks. Under favorable conditions, the sound carries for as much as a mile. Small blackbacked males, females, and youngsters produce a mere slapping sound when they beat their chests.

At the climax of the display, gorillas may beat not only their chests but also other parts of the body, and even other objects, in a variety of ways. The animals frequently slap their abdomens. One blackbacked male bea
the outsides of his thighs, a metho
also commonly employed by a mal
in the Columbus zoo. Females beat
the backs of their infants while holding them to the chest or while the
young are sitting in front of them
Branches and logs are often slapped
either with one or both hands.

SOME infants, aged to three years
and one blackbacked male beat
their chests with greatly exaggerated
gestures, extending their arms considerably after each slap. Two females
exhibited a circular motion of the arms
instead of direct alternate slaps. They
rapidly moved the lower arms and
hands close to the chest in a clockwis
or counterclockwise direction and
struck their breasts in passing.

In two instances gorillas beat un

CHEST-BEATING females usually sprea
the fingers slightly during display, *left*

sual parts of the body, seemingly in lay. One juvenile—juveniles are from ree to six years old—patted the top f its head with alternate hands about irty times; a blackbacked male lay n his back with legs stretched toward e sky, slapping the soles of his feet.

Like hooting, chest beats frequently licit the same display in other gorils. Sometimes one or two animals ait as the male goes through the preminary displays, then rise and beat eir chests in unison at the climax. hest beats by a male in one group ccasionally stimulated a male in another group some distance away to ehave similarly.

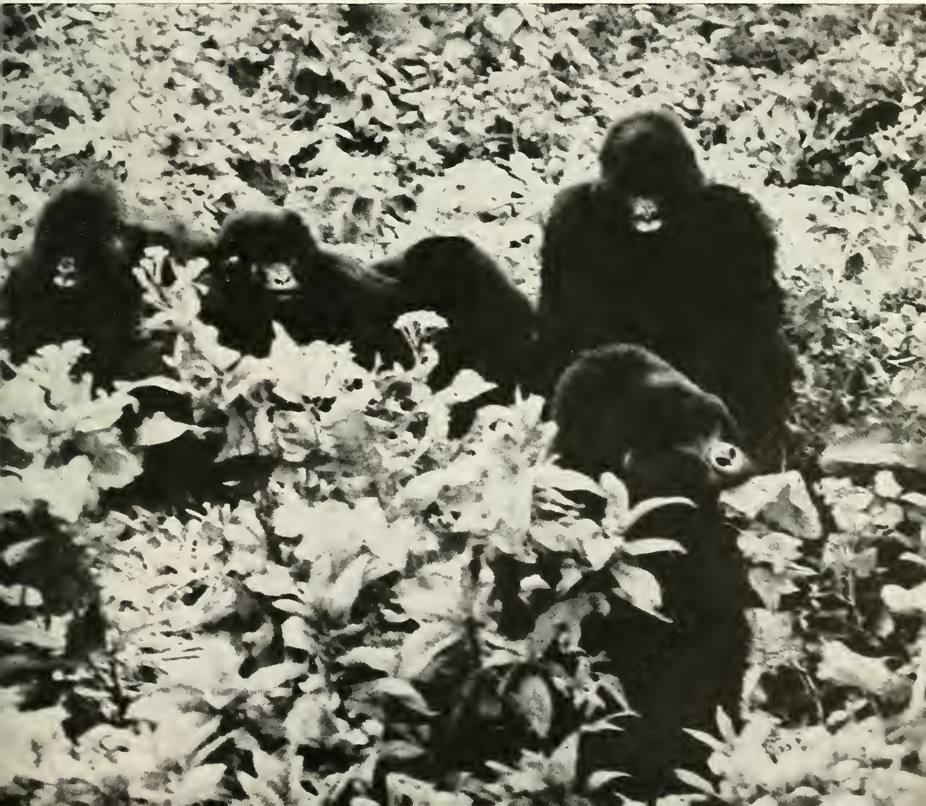
At the completion of the chest beat, orillas frequently remained standing r ten or more seconds to watch me s though waiting for a response on y part. Sometimes a gorilla popped from the vegetation, displayed, and then ducked back behind the screen of brush, after which it peered out at me intently. Blackbacked males and juveniles occasionally displayed with great abandon, then sat quietly, and looked all around as if to judge the effectiveness of their behavior.

Leg-kicking often accompanied the chest-beating. Usually the animal centers the weight of its body on one hind limb and kicks the other one sideways with the knee bent. Only rarely is the leg brought forward unless it is sharply bent at the knee. Sometimes the toes grab some herbs, which are thrown into the air. The leg is usually lowered gently to the ground, but occasionally the animal stamps it down forcefully, producing a dull thud. The tendency to kick the leg, which appears in approximately one-third of the standing chest-beating displays, is also evident in sitting animals on occasion. While beating the chest, they push one leg to the side, or merely flex it slightly. I noted a few instances in which animals in a standing display flexed both knees and actually jumped several inches into the air.

Immediately after and sometimes during the chest beat the animal tends to run bipedally sideways anywhere from five to twenty feet before dropping to a quadrupedal position and terminating its dash by checking momentum and slapping at vegetation.

If the gorilla displays on a slight elevation such as a stump or log, it may dive forward, with arms extended over the head or in front of the body, landing with a crash on the ground below. On a steep slope the fall may

Before beating chest, male at right of group shows "symbolic feeding" part of over-all display by placing leaves between his lips as the others watch.



LARGE MALE, in profile at left, yawns broadly as the group, composed mainly of females and juveniles, sits in midst of lush vegetation. Most gorillas rise on their hind legs and stay bipedal for several seconds before the chest-beating.

be five feet or more and, judging by the air forcefully expelled through mouth and anus, the animal hits with a considerable jar. It usually lands with the hind legs slightly before the front ones, and then continues its run forward for several steps in a quadrupedal position.

WHILE in the running stage of their display, gorillas tend to slap, break, and pull at any vegetation that grows within their reach. This may take several forms:

(a) The animal may run and sweep its arm through the vegetation, or swat at the weeds with an overhand motion and with arm extended. This is one of the most characteristic gestures. In adult males it may be dangerous, not only because of its violence, but also because of its unselectiveness. Any member of the group standing near the male is likely to be hit. One juvenile was picked up by a male and bowled down the slope. Another male reached over with both hands, pulled in a female by the hips, and swatted her on the back.

Man in the path of a running male gorilla apparently is also treated to the overhand swipe. Two quotes from Merfield and Miller (1956) illustrate this: "He opened his mouth, showing long yellow, canine teeth, and let out the most terrible scream I had ever heard as he brought his arms crashing downward, sweeping the canes with them, and striking me heavily on my left side . . ." and, "N'Denge was holding his gun loosely pointing downward, and was looking toward me, when a big male gorilla . . . crashed out of the bush and swept him aside with a terrible blow full in the face."

(b) A running gorilla frequently grabs a sapling or log near its path. The momentum may carry the animal in an arc around the tree.

(c) Running or sitting animals may break branches growing above them. A gorilla sometimes reaches above his head and with a violent downward pull rips a branch from a tree. Once a large silverbacked male jumped up and grabbed a branch that, however, failed to break. The male hung by his arms and looked around—a somewhat incongruous anticlimax to the preceding forceful display.

The final gesture in the complete display, and one fairly often heard or seen by itself, is a single, vigorous ground thump. The gorilla stands bipedally or on three legs with one or both hands raised to face height or above the head before slamming them down onto the ground. Once a silverbacked male clasped both hands over one shoulder in the manner of a winning prize fighter and then slapped them down. The animal usually slaps the ground with flat palms or, rarely, with the back of the hand. The overhand motion may be carried into a sweeping movement that causes vegetation and dirt to fly. Thrown or slapped vegetation sometimes flies inadvertently in the direction of another group member. The response of gorillas to such flying objects is similar to that of man: they flinch, duck, and cover the head or face with hand or arm. When a female flipped a branch toward the face of a juvenile, it held one hand with spread fingers in front of its nose. Once while eating lunch, I flicked a piece of paper at a blackbacked male who sat within fifteen feet of me, and he jerked his arm above his head. Similar responses can also be elicited by making incipient throwing motions. When, for example, I suddenly raised my camera to photograph a blackbacked male, the animal bent its arm so that both the fore and upper arm covered the side of the head.

Except for the leg kick, all acts in the full chest-beating sequence occurred also by themselves, although many of them, such as the bipedal posture, running, and slapping could not always be classed as displays.

NUMEROUS combinations of the nine acts exist, with some tending to precede or follow one another more frequently than others. The frequency depends on the gorilla's sex, on the intensity of the display, and on individual variation. I have only seen silverbacked males give the complete sequence of nine acts, and even with them I have observed it only a dozen times. Silverbacked males also tend to average more individual acts in each display than do other group members.

Infants displayed various acts of the sequence at an early age. When only four to four and a half months old they rose shakily and very briefly onto their hind legs and beat their chests. They also swatted at the vegetation. Small infants never reacted to my presence by displaying; the earliest age at which an infant reacted to me by beating its chest was one and a quarter years. Infants were first seen to place a leaf between the lips prior to chest-beating at the age of one and a half years, and I also first noted throwing at that age. Juveniles exhibited all acts in the display sequence except those of hooting and running.

I heard hooting in its full form only in adult males. Although females occasionally emitted a panting sound while beating the chest, this bore little resemblance to the clear hu-hu of males. Small blackbacked males never hooted. However, they exhibited the first rudiments of the sound when, before a chest beat, they sometimes uttered a single squeaky note. The sideways run likewise reached its fullest expression in adult males; I saw it only twice in females.

Although all parts of the display sequence, except the hooting and possibly the kick, were given by females as well as males, displays in females were less frequent, less intense, and of shorter duration than those of males. One female placed a leaf between her lips, rose, stepped sideways while beating her chest, and finally slapped the vegetation—an unusually complete performance for a female. The threshold of excitation also appeared to be higher in females than in males, which is perhaps related functionally to the male's being the group protector.

Six situations were observed to elicit all or part of the chest-beating display:

1. *The presence of man.* The most intense, prolonged, and diverse displays are exhibited by gorillas unhabituated to the presence of man.

2. *The presence of another gorilla group or a lone male.* If members of one group hear the distant hooting, ground-thumping, or chest-beating of another group, they may either ignore the sounds or respond by displaying. Frequently the silverbacked males are the only members of the group that react at such times.

Infant, so called if it is less than three years old, is on female's back, *above*.

Hair on the backs of adult males of ten years or more is silver-colored, *below*.

When seeing each other, two groups commonly display by beating the chest, thumping the ground, and slapping the vegetation. Most displays are given by the males, although some chest-beating occurs also in females and juveniles.

3. *In response to an undetermined disturbance.* Gorillas that note fleeting glimpses of moving objects, such as a partially hidden observer, become uneasy until they have determined the nature of the disturbance. The whole group sometimes approaches, with several of the animals beating their chests, throwing herbs, thumping the ground, and slapping the vegetation.

4. *Displays by another member of the group.* Displays are contagious, in that such behavior in one animal sometimes induces another to act likewise. This is especially noticeable among males. Females, blackbacked males, and juveniles frequently display simultaneously and in unison with the silverbacked male.

5. *Play.* Playing infants rise to beat their chests, they slap at vegetation, and they sometimes place a leaf between the lips.

6. *Without apparent outside stimulus.* Gorillas occasionally start seemingly spontaneous movements of the fingers and hands in the pattern of the chest-beating display while they are sitting or lying quietly.

The hooting, the bipedal stance, the vegetation held in the mouth and thrown about, the kicking, the running and breaking of vegetation—all these are actions that serve to make the animal conspicuous. It seems actually to be advertising its presence or "showing off." Human response tendencies and those of other gorillas suggest that the display serves to repel intruders by intimidation.

THE displays also appear to have secondary communicatory value both within the group and between groups. Group members become alert if the dominant male beats his chest without obvious reason, and they become aware that another group or a lone male is in the vicinity upon hearing displays in the distance.

Yet intimidation and communication alone do not explain the causes of display in several other situations. Why, for example, does it occur prominently in play, and why do gorillas beat their chests when there is nothing obvious to intimidate or communicate? Yerkes (1927) "gathered the impression that chest-beating indicates impatience or other mild dissatisfaction, sometimes lonesomeness or slight irritation, and that it may be done to attract attention or to startle or intimidate the observer."

The most general emotional term that encompasses all the diverse manifestations of the display is excitement. Gorillas are excited in the presence of man, at the visual or auditory proximity of another group, and during play. When displaying, the animals find release for the tension that has accumulated in their system in an excitable situation. Thus, the primary causation of the chest-beating sequence appears to be the buildup of tension (excitement) above a certain threshold. After the display, the level of excitement temporarily drops below the threshold, and the animals behave calmly until a new accumulation of tension erupts in display.

Following the concepts of causation as developed by various investigators, a potentially dangerous situation, such as a meeting with a human being, arouses two conflicting impulses in the gorilla. On the one hand, the animal exhibits a tendency toward flight, on the other aggressiveness, with the result that it neither flees nor approaches. The conflicting tendencies of "flight or fight" generate tension in the animal. This tension finds release in some functionally inappropriate but fairly stationary act like throwing, beating something, and jumping, or in a more restrained act like symbolic feeding. Thus, in a situation that arouses conflicting tendencies, the animal expresses itself by some behavior that is not actually relevant to the situation at hand. Such behavior is termed a "displacement activity." Several of these displacement activities have apparently become stereotyped in the gorilla; they have become incorporated into a definite display, and in this development have achieved such secondary functions as intimidation. In the ethological terminology they have become ritualized.

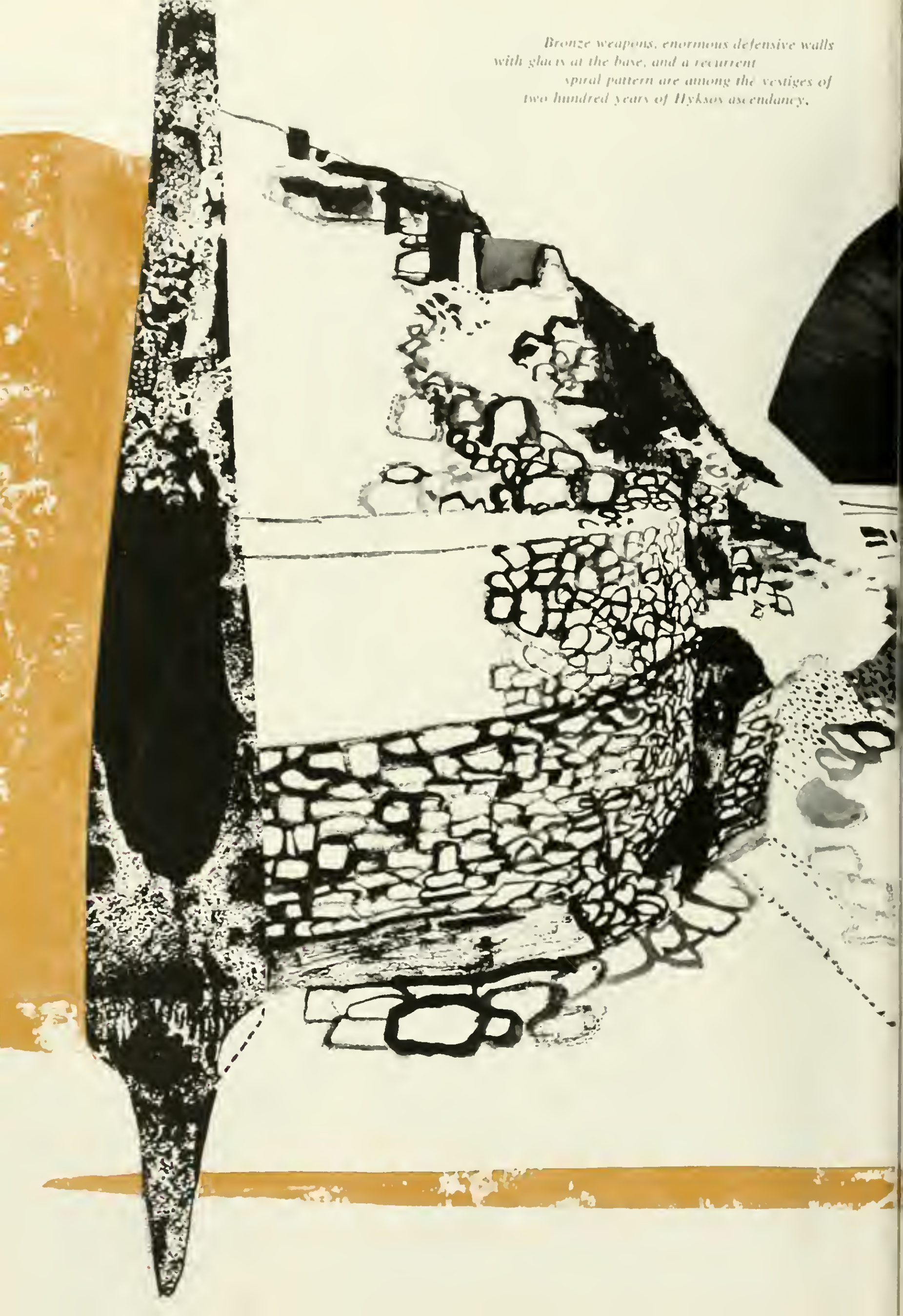
With the gorilla I have found it difficult to distinguish between behavior that is simply displacement and that which has become ritualized, although both elements can be seen in the symbolic feeding portion of the full display. At their first sight of me, males occasionally began to feed very intensively. This appears to be displacement feeding. Sometimes a male will stuff three or four handfuls of vegetation into his mouth before rising to beat his chest. At other times, the vines or herbs are not pushed into the mouth, but are gently placed between the lips, the amount varying from a big handful to a single leaf. These latter acts appear to be almost entirely ritualized.

VARIOUS aspects of the chest-beating display sequence are present in the gibbon, orang-utan, chimpanzee, and man, although the specificity is sometimes lacking. For example, wild gibbons in Sarawak hooted several times before the climax, which was marked by sounds of very high pitch, bipedal running, and a final rapid swinging through the trees. The similarity to hooting, rising, and running in gorillas is obvious. Orang-utans broke off and threw branches when excited. Chimpanzees in Uganda shook branches and beat the edge of the nest with both hands in response to my presence. A large aggregation of chimpanzees in the Budongo Forest in Uganda hooted at first slowly, then increased the tempo and loudness of the vocalization until at the climax they screamed, slapped branches, and beat the hollow buttresses of ironwood trees (*Cynometra*) with their hands to produce a loud drumming sound. In zoological gardens I have observed chimpanzees throw objects, slap floors, walls, and themselves, and stamp their feet, thus exhibiting most of the displays that have been noted in gorillas.

Man behaves remarkably like a chimpanzee or a gorilla when faced with conflicting situations. Sporting events are ideal locations for watching the behavior of man when he is generally excited and emotionally off guard. A spectator at a sporting event perceives actions that excite him. Yet he cannot participate in them directly, nor does he want to cease observing them. The tension thus produced finds release in chanting, clapping of hands, stamping of feet, jumping up and down, and the throwing of objects. The intermittent nature of such behavior, the transfer of excitement from one individual to the next, and other similarities with the displays of gorillas here described are readily apparent.

FEMALE squats in crotch of a tree, top, with her infant. A young male is on the trunk next to a chest-beating female.

Bronze weapons, enormous defensive walls with glacis at the base, and a recurrent spiral pattern are among the vestiges of two hundred years of Hyksos ascendancy.



Rulers in the East

Hyksos horse-drawn war chariots conquered Palestine and Egypt

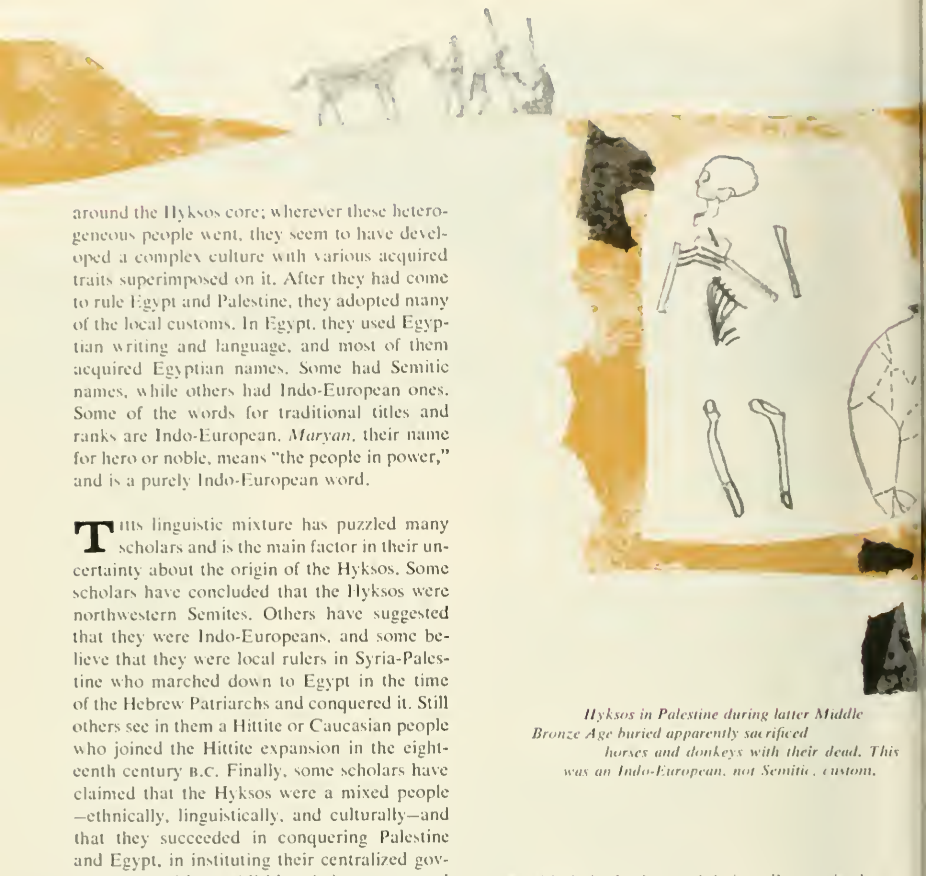
By Emmanuel Anati

Drawings by Richard M. Powers

Few problems have preoccupied Near Eastern archeologists as much as that of the origin of the Hyksos, whose rule started in Palestine shortly after the middle of the eighteenth century B.C. and lasted for about two hundred years. Hyksos material culture, however, seems to have infiltrated the area before the beginning of the political conquest, appearing and evolving in Palestine during the twentieth and nineteenth centuries B.C. and in Egypt almost simultaneously during the Twelfth Dynasty.

The Hyksos are believed to have introduced into Palestine and Egypt the domesticated horse and the two-wheeled war chariot, which, at about the same time, reached Anatolia with the Hittite expansion, not arriving in Greece until the sixteenth century B.C. The Hyksos, now known only by their Egyptian name, imposed their rule upon Palestine and Egypt and introduced their exotic culture into these countries. A great deal is known about the Hyksos—about their material culture, their customs, their beliefs, their towns and fortifications, their methods of waging war, their social and political organization—but their origin is still obscure.

It seems that other peoples probably gathered



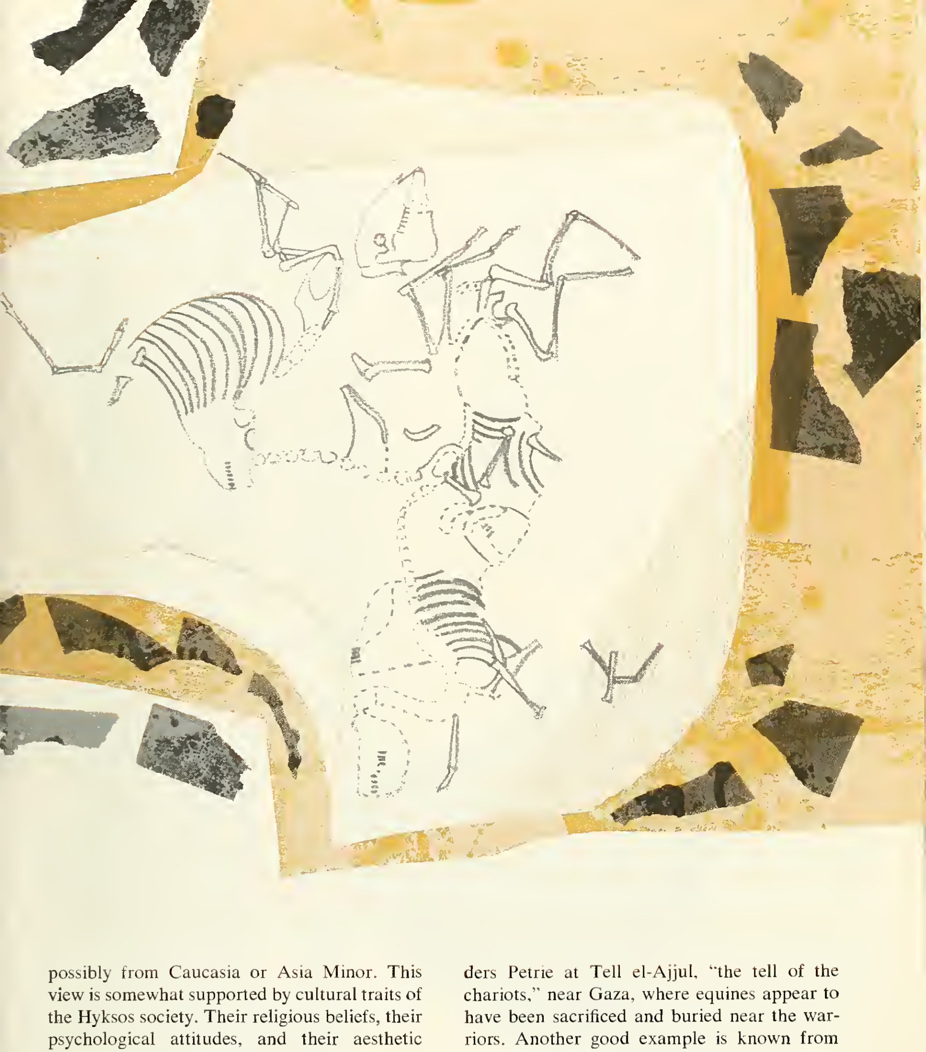
Hyksos in Palestine during latter Middle Bronze Age buried apparently sacrificed horses and donkeys with their dead. This was an Indo-European, not Semitic, custom.

around the Hyksos core; wherever these heterogeneous people went, they seem to have developed a complex culture with various acquired traits superimposed on it. After they had come to rule Egypt and Palestine, they adopted many of the local customs. In Egypt, they used Egyptian writing and language, and most of them acquired Egyptian names. Some had Semitic names, while others had Indo-European ones. Some of the words for traditional titles and ranks are Indo-European. *Maryan*, their name for hero or noble, means "the people in power," and is a purely Indo-European word.

This linguistic mixture has puzzled many scholars and is the main factor in their uncertainty about the origin of the Hyksos. Some scholars have concluded that the Hyksos were northwestern Semites. Others have suggested that they were Indo-Europeans, and some believe that they were local rulers in Syria-Palestine who marched down to Egypt in the time of the Hebrew Patriarchs and conquered it. Still others see in them a Hittite or Caucasian people who joined the Hittite expansion in the eighteenth century B.C. Finally, some scholars have claimed that the Hyksos were a mixed people —ethnically, linguistically, and culturally—and that they succeeded in conquering Palestine and Egypt, in instituting their centralized government, and in establishing their customs and culture, thanks to their superior weapons. They were successful in spite of their lack of a common language. All these hypotheses are strongly defended, and most of them have convincing arguments to support them. Whatever may be the truth, by the time the Hyksos became rulers and entered history, some of them had probably already spent several generations among the peoples they had conquered.

It is very likely that the wave of people who invaded Palestine in the eighteenth century B.C. with their chariots and their well-organized army was a single body, well trained and used to discipline and to central rule. But apparently they were preceded by smaller, kindred bands who had settled in the region and had slowly mingled with the local population; they brought with them several dominant Indo-European traits of language, ways of life, artistic outlooks, religions, and beliefs.

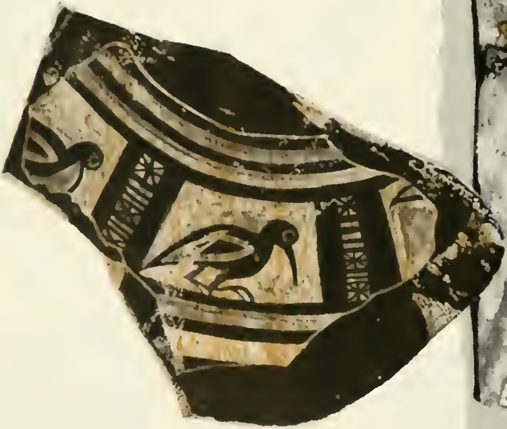
The Hyksos rule appears to have brought to both Palestine and Egypt a great many similar political and social changes of foreign origin,

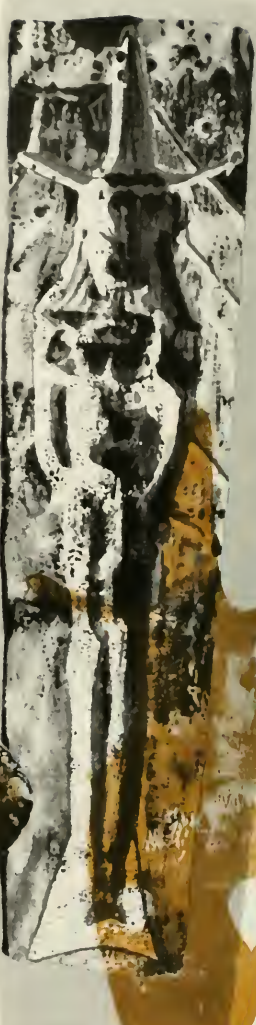


possibly from Caucasia or Asia Minor. This view is somewhat supported by cultural traits of the Hyksos society. Their religious beliefs, their psychological attitudes, and their aesthetic values are useful indicators of origin.

One of the cultural traits of the Hyksos rulers of Palestine in the latter part of the so-called Middle Urban (or Middle Bronze) Age was their custom of burying the dead with their horses and donkeys. The best examples in Palestine of this custom were found by Sir Flinders Petrie at Tell el-Ajjul, "the tell of the chariots," near Gaza, where equines appear to have been sacrificed and buried near the warriors. Another good example is known from Professor Kathleen D. Kenyon's excavations at Jericho. This is in sharp contrast with all we know of early Semite practices, but is a well-known Indo-European practice. In Caucasia and southern Russia, both horses and models of wheeled vehicles are frequently found in tombs belonging to the third millennium B.C. In the Mycenaean royal graves in Greece, the actual horses and vehicles of the Asiatics and the vehicle models of the southern Russians were replaced with high reliefs carved on the funerary stelae. Graves with horses and vehicles also turn up in central Europe in the Urnfield culture, which was established late in the second millennium B.C. and is believed to have been Indo-European. This custom persisted in Europe among such later Indo-Europeans as the Celts and the Scythians.

ANOTHER hint regarding the origin of the Hyksos is provided by their peculiar decorative style. The principal Hyksos designs are found chiefly on their seals, their ornaments, and their pottery. They were the solar wheel, the spiral, the wavy and interlocked spiral, and other designs that were predominant among the early Indo-European populations of Greece and were later to become the symbols of all the Celtic populations of Europe. The spiral is believed to have originated in the solar symbol





Late 16th- or early 15th-century B.C. *shard typifies "Bichrome Ware" phase following Hyksos retreat. Modern cast of Astarte was made in an ancient mold found at Nahariya.*

and the solar cult. The turning solar disk evolved in many different shapes. It may be depicted in isolation or in repeated patterns.

In Palestine, the spiral is an imported decorative element. Before the Hyksos, some rare spirals are found in the decorations of the Khirbet Kerak ware, which was of Caucasian origin. Thereafter, the spiral was virtually absent until the beginning of the Hyksos period. Then suddenly it became a dominant element in the decoration of seals and ornaments, and it also occurs on contemporary pottery.

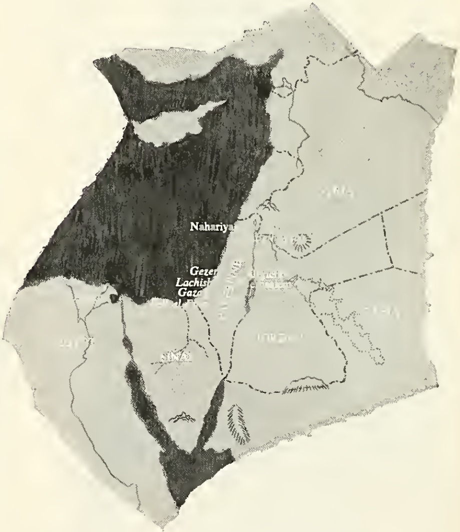
Among all the thousands of decorative designs in the rock pictures of Sinai, the Negev, Jordan, Syria, and Arabia, there is not a single spiral dating from prehistoric times to the beginning of the second millennium B.C. When we compare this with the importance of the spiral in Hyksos decoration, we realize how productive the story of a decorative pattern can be. In Egypt during the Old Kingdom, the spiral was an extremely rare element of decoration, and when it appeared in the First Intermediate Period it was probably imported from Asia. It was used more often during the Middle Kingdom, but not until the time of the Hyksos rule did it become the dominant decorative design.

West of the Tigris, for a very short period in prehistoric Elam, the spiral was used as a decorative design together with the swastika and other shapes. These same designs turn up again, sporadically, at the sites of Shah Tepe, Tepe Giyan, and others in Iran. Yet, in such rich decorative repertoires as that of Early Dynastic Ur, in southern Mesopotamia, the spiral plays a secondary role, and it is a very sporadic element in Early Urban times (before the nineteenth century B.C.) throughout the Fertile Crescent, although it occurs in Caucasia and at Troy. The spiral came into widespread use in Palestine with the Hyksos, and it was diffused throughout Asia Minor at about the same time, early in the second millennium B.C., with the rise of the Hittite Empire.

Decorative designs are more than a random and unconscious gesture of the artist's hand. They illustrate a way of thinking and a psychological background, and are the fruit of a culture and a tradition. All in all, a great many exotic features were introduced into Palestine by the Hyksos, and they all seem to have come from a similar source. Their origin must be looked for somewhere to the east or north of the Fertile Crescent.

As we have pointed out, the war chariot and the domesticated horse reached Anatolia with the Hittite expansion, at about the time the Hyksos were conquering Palestine and Egypt. The same two traits reached Greece at the beginning of the Middle Mycenaean culture, in the sixteenth century B.C., and spread to Europe shortly thereafter. Before the Hyksos, the Hittites, and the Middle Mycenaeans, traces of these traits are scanty, but some do exist.

Wheeled vehicles seem to have originated in Sumer (in the Uruk period) toward the middle of the fourth millennium B.C. Their use spread from southern Mesopotamia and reached the Indus Valley, Caucasia, and northeastern Syria by the second half of the third millennium B.C. These early wagons were heavy and slow, usually drawn by oxen. Only late in the third

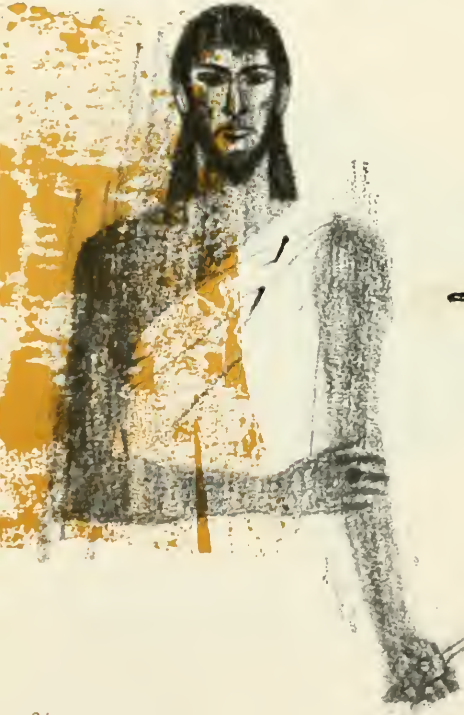


Map of Egypt and Palestine indicates the location of sites where traces of Hyksos have been found. Avaris was capital city of the Hyksos Empire in the Nile Delta.

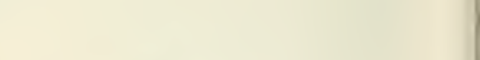
millennium or at the beginning of the second millennium B.C. do we meet with lighter vehicles, probably early types of war chariots. They are depicted on Anatolian seals and occur in the form of models at Hama on the Orontes River and Qatna in northern Syria.

At present we are unable to trace the origin of the light war chariot back further, but there were two prerequisites for such an invention—a suitable terrain and fast horses. This vehicle, which turned out to be a tremendously powerful weapon, is unlikely to have been created by people living in mountainous, heavily forested, or desert regions. The inventors must have lived on broad flat plains, grasslands, or some other similar terrain. Large areas of this kind are not to be found in the Near East, and must be looked for either more to the north, on the southern Russian steppe, or more to the east, on the Iranian Plateau. (Another possibility would be northern Syria, but neither documents nor archeological discoveries allow us, so far, to put much faith in this conjecture.) It is likely that the seminomadic horse breeders of the steppes or the flat plateau were the people who could transform the slow, ox-drawn, wheeled vehicles into the light war chariots that gave them a tremendous superiority over foot soldiers. This was one of the weapons with which they invaded and conquered more civilized regions that lay to the south.

It is not now possible to locate more precisely the place of origin of the war chariot and the domesticated horse; but if it were, the place would probably be among an Indo-European people living before the late part of the third millennium B.C. As we shall see, the forti-



Reconstruction of Hyksos man illustrates method of fastening costume at shoulder with a toggle pin such as the one below. No actual depictions of Hyksos are known.



fication and defense methods used by the Hyksos also point to northeastern origins.

In the intermediate period (Early Bronze Age IV and Middle Bronze Age I), the Near East underwent great changes. Except for Mesopotamia, not a single region was then economically and politically stable, and this turmoil must have prepared the way for the Hyksos when they arrived with their new weapons and their well-organized armies. The Hyksos and their affiliated bands brought with them new types of weapons, military tactics, and military architecture. At Gezer, Beth-yerah, and other Palestinian sites there is a characteristic feature of the military architecture, dating from early in the second millennium B.C.—a sloping glacis at the foot of defense walls. This is a construction of terre-pisée, stone, sun-dried bricks, or other materials extending outward from the fortification and forming an artificial slope, which frequently ended in a moat. This glacis gives a totally new shape to the fortification and, indeed, to the town and to the tell as a whole. In later times it reached enormous dimensions, sometimes extending to over a hundred feet out from the wall of the fortress.

THE reasons that led to the building of this new military device were in dispute among archeologists until Yigael Yadin, of the Hebrew University, found the solution. The most popular previous idea was that the use of war chariots had inspired the use of a glacis to keep the chariots away from the wall. Professor Yadin, a onetime chief of staff of the Israeli Army, observed that chariots can be decisive in open warfare but are of little use in attacking a walled city. He went on to show that the new weapon

Scarab on king's signet ring rotates to show face or seal with compressed spiral design. The alabaster box lid, at right, bears a Hyksos ruler's name and titles.

that inspired the change in defense work must have been the battering-ram. This weapon was gradually adopted in Early Urban times, and a scene showing it in use in a breaching operation is depicted in a Fifth Dynasty picture from Egypt. The term for battering-ram already existed in Mesopotamia during the third millennium B.C., but it seems that in Syria-Palestine and Egypt it became an important weapon of attack only with the Hyksos. The Hyksos rulers built enormous defenses based on the glacis. Later, the terre-pisée glacis was replaced with stone walls of massive polygonal masonry with sloping outer sides.

Very similar defense systems appear in some early Hittite towns in Anatolia and throughout northern Syria. Palestine, however, has the greatest number of them. In the vicinity of some of these tells the Hyksos built huge fortified enclosures, usually of rough rectangular shape, surrounded by sloping ramparts of terre-pisée. Probably the mercenaries were sheltered here, as well as the various camp followers in the service of the nobles, who lived in the fortress. (As pointed out by N. Kalinin, there is a strange resemblance between these enclosures and the fortified encampments of the seminomadic warriors who inhabited the Tatar steppe.)

THE burial methods of Hyksos times were not uniform in Palestine. Some older tombs were sometimes re-used, others with vertical shaft and a burial chamber at the base seem to continue traditions of Intermediate times. At Megiddo there are tombs of this period in which several individuals were buried together; other types of communal and single tombs were also found. However, the typical Hyksos tombs seem to be best illustrated by the communal tombs of Tell el Fara, Jericho, Lachish, and other sites in central and southern Palestine, where the bodies were interred in artificial burial caves together with their grave goods and sometimes also with sacrificed animals.

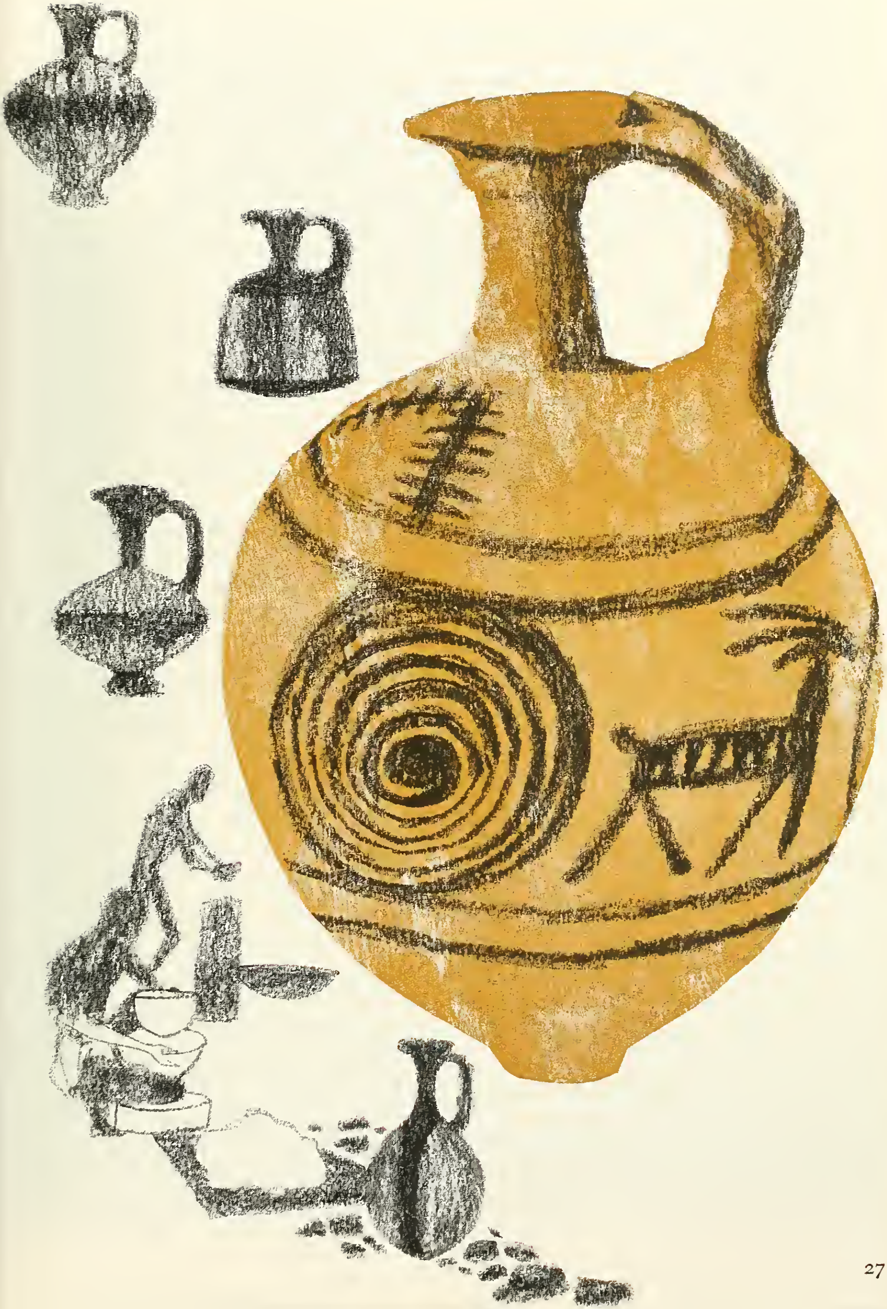
The material culture of this period is today well known from a series of excavations. The evidence of pottery forms and of metal tools and weapons is from this time on supplemented by a great abundance of scarabs—the personal seals of officials and nobles—which frequently provide the archeologist with precise dating.

THE pottery forms are marked by carination on chalices and goblets and by elongated and softly curved small jugs. Bowls with harmonious forms and ring bases, which are low and cylindrical, show that many of the forms were probably inspired by metal prototypes. Coloring is frequent and varied; on small pots the most common is a dark gray that is often burnished. There is also a type of small jug, with a pen-shaped body and a small button-like base, dark and roughly burnished and with pitted triangles and other geometrical patterns; it is called the Tell el-Yahudiyah juglet, after the modern name of its type site, which was once Avaris, the capital of the Hyksos Empire on the Nile Delta. This juglet is found throughout Syria-Palestine, Cyprus, and Egypt in this period, and its distribution probably delimits the range of Hyksos influence.

Sporadic contacts were much more extended than that. To occasional intercourse with the Semitic rulers of Mesopotamia may be added overseas relations, one of which was dramatically disclosed by an alabaster lid inscribed with the name and titles of the Hyksos ruler Khyan, found at Knossos, in Crete, by Sir Arthur Evans. Trade must have been highly developed by this time, and one may suppose that within the Hyksos sphere of influence communication was very active, as there are no fundamental regional variations in the material culture.

The Hyksos rulers were driven out of Egypt early in the sixteenth century B.C., and the Pharaonic army, after the three-year blockade of Sharuhen, a city-fortress in the Negev, occupied Palestine and made it an Egyptian province. At this time, early in the Eighteenth Egyptian Dynasty, Palestine was spoken of as the Land of the Canaanites, but its ethnic composition was extremely mixed, and the basically Semitic population included a great many other elements. Exotic names of princes and chieftains were to continue to turn up later in the Tell el-Amarna letters and in other texts that throw light on the period of their Egyptian rule.

Spiral, a major motif in Hyksos designs, was on seals, ornaments, and pottery, in many variations. It may have originated in the solar symbol and the solar cult.



The Shell Menace

Behavioral aspect of camouflage is demonstrated by gulls

By Niko Tinbergen

WHEN A CHICK is about to hatch, it cracks the shell near the obtuse end. Then, by rhythmic stretching movements (for which chicks have a muscle that degenerates after hatching) it lifts off a small "lid" and half-rolls, half-crawls out of the shell.

In some species, such as gallinaceous birds and ducks, the parents rarely if ever pay any attention to the empty egg shells; they lead the young away as soon as they are dry, leaving nest and shells behind. Most other birds dispose of the shells in one way or another. Hawks are reported to eat them, as a general rule; grebes take them in their bills and "drown" them some distance from the nest. Most birds fly away with each shell and drop it a good distance from the nest, although not at any particular place. Black-headed Gulls (the Old World cousins of Bonaparte's Gull) do this regularly, and while there is variability in the time, few if any fail to remove a shell within two hours after hatching; sometimes they do it within a matter of minutes.

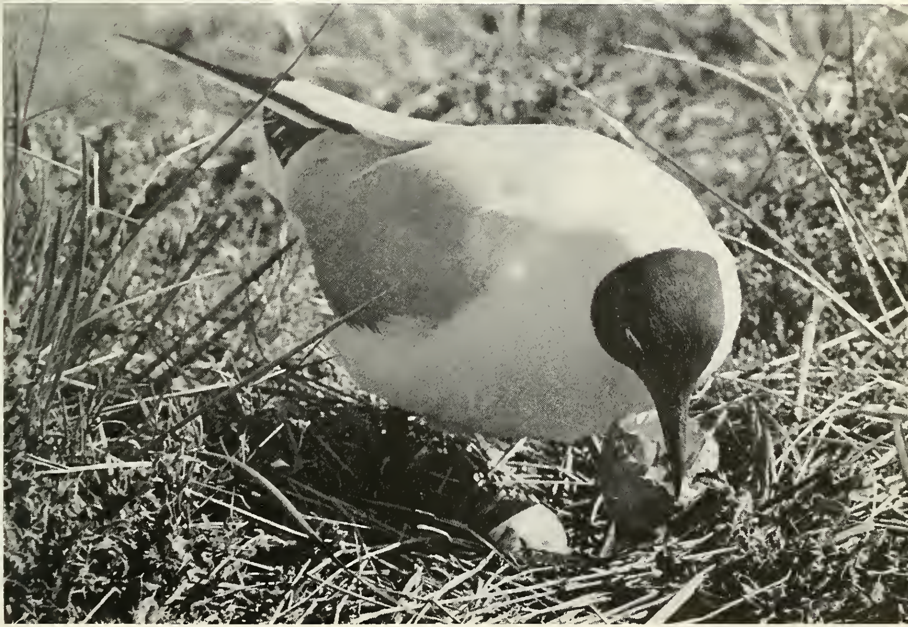
One could hardly imagine a more trivial response, for it takes no more than, at most, thirty seconds of a bird's time each year—between three and ten seconds for each of its three eggs. Yet, as biologists, we have gradually become convinced that very few such regular occurrences are really insignificant. When my friends and I began to look more closely at egg shell removal, we began to suspect that it must in some way be a very useful response. The argument was indirect. We had noticed that several predators, such as Carrion Crows, Herring Gulls, and even neighboring Black-headed Gulls, were often quick to seize an egg or a newly hatched chick, in spite of the fact that their khaki coloring and dark blotching make them difficult to detect. It is not for nothing, therefore, that broods are rarely left unguarded. Parent gulls take turns at the nest and the "on duty" bird seldom leaves before having been relieved by its partner. When a gull flies away from the nest to dispose of the egg shell, and so leaves the brood unguarded for something between three and ten seconds, even this short absence can be heavily penalized when a crow dashes down for a "grab and fly" robbery. So when, despite this threat, all members of the species take the risk, we must suspect that there are advantages that outweigh the disadvantage, or the habit would have been eliminated by natural selection. Therefore, we speculated, there must be something that penalizes the broods that have "untidy" parents.

As to the nature of the penalty, there were several possibilities. An empty egg shell might slip over an unhatched egg, and so trap the chick inside. This has actually been observed in birds that lay eggs with strong shells. The sharp edge of the broken shell might injure the chick. This, too, has been reported—by poultry breeders, for instance. Another possibility was that three shells left in the nest might interfere with the parents' efficiency in brooding the chicks. After all, a gull has only three brood spots—one for each egg or chick. Neither of these three possibilities seemed probable in our species, which has extemely thin shells that are easily crushed. Nor did we think much of the possibility that the moist, organic material that is sometimes left in the shell could be a breeding ground for pathogenic bacteria: the shells usually dry quickly. We were rather inclined to think of a fifth possibility: the shell, by being white inside and thus, at least to us, very conspicuous, might attract the attention of predators—such as crows and Herring Gulls, which hunt by sight—by helping to reveal the otherwise camouflaged brood. The gulls will remove not only egg shells but many other objects from their nests (such as mussel shells, bits of paper, leaves, and even bottle tops), which seemed to support this theory. Even more suggestive was the fact, reported by my co-workers Dr. and Mrs. Cullen, that while many species of gulls and terns remove their egg shells, the Sandwich Tern and the Kittiwake lack the response—and these two species are exactly those members of the group that have no camouflaged broods. The eggs of Sandwich Terns, although blotched, are very conspicuous, and the down of a Kittiwake chick is almost uniformly silvery-white.

When, in 1959, some of our guest workers were keen to tackle this problem with me, we decided to study it systematically in the large gulleries near Ravenglass, which is situated on a sandy peninsula on the Irish Sea coast of Cumberland, England. This was the beginning of a three-year study, in which I was joined at one time or another by Dr. G. J. Broekhuysen of Capetown, Miss C. Feekes of Utrecht, J. C. W. Houghton of Leeds, H. Kruuk of Utrecht, Miss M. Paillette of Paris, Dr. E. Szulc of Warsaw, and Dr. R. Stamm of Basel.

Two questions were posed. First, does or does not an egg shell, if left in or near the nest, expose the brood to increased predation? Second, how does a gull "recognize" an empty egg shell and how does it distinguish that shell from intact eggs, chicks, and nest material, none of which we ever observed a gull to carry?

Black-headed Gull, with its distinctive white eye ring, calls, *opposite page.* Bird prepares to pick up a broken egg shell, *below*, and remove it from the nest. This behavior is one way in which gulls protect the colony from predation.



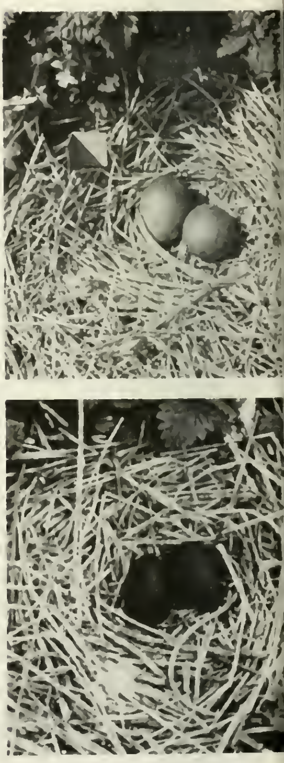
BLIND from which observations were made is in position on the Irish Sea coast in Cumberland, where thousands of gulls were available for the tests.

We worked on the assumption that the egg shell would make the brood more conspicuous. Although this is so, at least to human eyes, in no species with allegedly camouflaged broods had it ever been put to the test with respect to the species' natural predators.

We laid out, singly and scattered over an open dune valley, equal numbers of natural-colored gulls' eggs and gulls' eggs that we had painted white. From an observation blind erected on a dune top we observed which predators would take them, and which of the two types of egg they would take most often. The area was regularly patrolled by several Herring Gulls and by Carrion Crows, which found and ate a number of the eggs. Each test was broken off when roughly half the eggs had been discovered. After a few weeks the results became clear: although both types of eggs were taken, both the gulls and the crows found more white than natural-colored eggs *(page 33, top)*. Not surprisingly, the crows, members of a tribe known for intelligence and keen sight, were better at finding eggs than were gulls. Also, the crows were extremely helpful to us, for unlike the gulls they did not stop looking for eggs when they were satiated, but continued to take and bury them, returning to such caches weeks after.

Later we repeated this experiment with painted hens' eggs. Half of them were uniformly khaki—a color that matched the base color of the gulls' eggs; the other half had irregular dotting added on the base color. Again, the uniformly colored eggs were taken in larger numbers than were the dotted eggs. The eggs, therefore, derive some protection from their coloration. However, since many of the natural eggs were found, the camouflage cannot be called very effective. Without the efficient manner in which Black-headed Gulls attack marauding crows, few gull eggs would survive.

Our next step was to test whether the presence of an empty egg shell next to a natural-colored gull's egg would endanger such an egg. Here we used a trick that I feel I must justify. We had seen that even a natural-colored egg could be found with relative ease. In the natural situation (that is, in the gulleries themselves) crows that entered the colony spent much of their time dodging the violent attacks of the gulls, while in our test area they were free of such attacks and could, as a result, look down continuously. We further realized that the prey, which in the natural situation would be betrayed by the egg shells, could be either eggs or chicks. Chicks are much better camouflaged than are eggs; moreover, they crouch in cover when the parents sound the alarm. So we decided to make things more difficult for the crows. All the eggs we laid out in the dune valley were covered with a few straws of marram grass, which



NEST with colored dummy is at the top; below are plaster eggs painted black.

improved the camouflage most strikingly (in fact, some plovers use this trick themselves). Half the eggs were single; empty egg shells were placed at some 10 cm. distance from each of the other half. We weighted the situation a little against the expected results by covering the eggs that had an egg shell next to them slightly better than we did the single eggs. Thus, the single eggs were a little easier to find. In spite of this, our predators—again Carrion Crows and Herring Gulls—found 65 per cent of the eggs accompanied by the extra shell, and only 22 per cent of the single eggs.

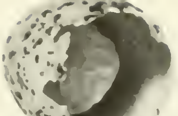
Because some gulls move the shell no more, perhaps, than a couple of feet from the nest, we experimented with varying the distance between the egg and the shell. The result was clear-cut: the farther the shell from the egg, the less danger to the egg *(page 33, center)*. In these tests we saw the crows alight near a shell, walk round for awhile, and then leave without having found the egg.

Could we now conclude the hypothesis had been proved? In our opinion, not quite. We had shown that the presence of a shell endangered the egg, but as we had conducted our experiments outside the gullery, there had been no gulls to guard the eggs. In the gullery, however, removal of the egg shell, apart from making the brood less conspicuous, also involves abandoning the brood for a brief time, thus exposing it to predation. We were not entitled to judge the over-all effect of egg shell removal, because in our tests neither category of eggs was ever guarded by a gull, and the effects of continuous guarding were therefore not comparable with those of interrupted guarding. However, we have good reasons to suppose that the advantage of removing the egg shell outweighs the disadvantage. For one thing, gulls either sit on the nest or attack when a crow or a Herring Gull enters the gullery; for another, if they did not remove the shells at all, these would be attractants for days, whereas the danger caused by removal lasts only a few seconds. Whether or not any of the other advantages mentioned above will later prove to exist as well, our experiments have convincingly shown that, at least in the Black-headed Gull, egg shell removal can be considered a behavior component of camouflage, and part and parcel of the species' defense against predators.

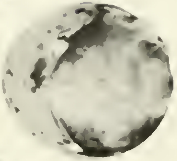
We next wanted to find out the stimuli whereby the gulls recognize the egg shell. Although they remove a great variety of miscellaneous objects in addition to shells this does not mean that they respond with equal promptness to all objects. We presented the gulls with a variety of dummy shells, and compared their responses to them. First we determined the length of the season during which the gulls would remove egg shells we provided. At various times in the breeding season, from weeks before the eggs were laid until well after the chicks had hatched, we gave hundreds of gulls an egg shell each on the rim of their nests and checked, after a standard period of six hours, how many of them had removed the shell. We found that the first responses, few and incomplete, appeared three weeks before the first egg was laid. After a gradual buildup, a high level of removal was reached while the eggs were being laid; this level was maintained throughout the incubation period (about twenty-four days), and it did not drop off until after the chicks had hatched. The level was so constant and so high that we knew we could test throughout the breeding season.

We could now begin to compare the different dummies. We made simple dummies that could easily be transported—rectangular strips of metal, 2 x 5 cm., and bent at right angles in the middle. Some of these we painted a light khaki; others dark khaki (equal to the color of eggs viewed from such a distance that the

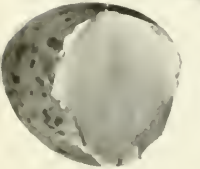
Halved ping-pong ball, painted color of natural egg on outside and white on inside, serves as dummy in tests. Gull removes it as if it were actual shell.



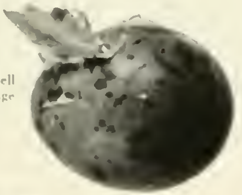
With lead pellet at pointed end



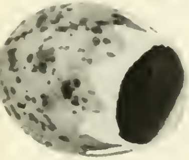
With cotton filling and visible edge



With plaster to rim

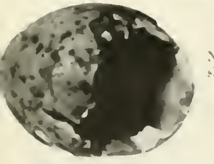


Whole shell with flange



Smooth rim with white

Smooth rim without white



Normal shell

SHELLS of different weights, contents, and construction tested gull reactions.

dots blurred); some white, some black, others bright red, yellow, or blue and others green. We marked a large number of nests and divided them into as many groups as we had models, with equal numbers of nests in each group. In one trial we gave each nest one dummy on its rim, with a different color for each group. After an hour we revisited all the nests and noted how many of each type of dummy had been removed. After having given the gulls a few hours rest, we repeated the test, continuing until each nest had received each color once. The different groups were presented with the dummies in a different order. After such a test we could directly compare the responses of all gulls to each model.

The results were rather surprising. The gulls did remove some of all the dummies, but some colors were removed much more consistently than others. It was clear that conspicuousness was no criterion. On the one hand, red, blue, and black were not carried away particularly often. On the other hand, both white and the khakis had a very high score, although white was extremely conspicuous and khaki was about the most cryptic color possible. Since we knew from other tests that the gulls had a good color sense, the only possible conclusion was that objects that had the same colors as real egg shells were most frequently removed, not those that were most conspicuous. The various green models (some of which were uniform, while others were dotted) had a very low score. This was particularly true of a shade of green that was very similar to that of young vegetation. The dotting made no difference, nor did contrast within one dummy (such as that offered by one that was khaki outside and white inside) raise the score.

THESE responses to color were obviously adaptive: strong responses to the natural main colors of the egg shell; a moderate response to objects of various bright colors that might occur in the natural situation (for instance, yellow, pink, and blue shells of snails and mussels are frequently kicked into the nest); and a low response to green. This latter reaction, we think, is adaptive, because the gulls showed little preference for particular shapes, and were quite willing to remove flat paper disks. Had they responded readily to green, they would probably also strip leaves from surrounding vegetation and so remove useful cover, in addition to leaving the nest unguarded far too often.

We tested various other properties of objects in much the same way. In some series we varied the shape of the models, in others the size, in others the distance between the egg shell and the nest. We found that the shape response was best to the real egg shell, second to halved ping-pong balls, third to the cylindrical rings, fourth to the "angles" we had used for our color tests, and fifth to the flat cardboard or metal strips.

EGG shells placed at various distances from the nest gave interesting results. As standard egg shells we used either real gulls' shells (gathered in masses at the end of each season and kept until the next year) or broken hens' eggs painted khaki.

The gulls' removal response fell off sharply with increased distance, just as did the predatory response of the crows. In this way we gradually acquired a rather good idea of the types of stimuli that to the gulls characterized an egg shell to be removed.

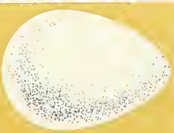
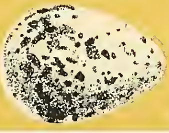
We now turned our attention to two other aspects of behavior. As we had seen, the gulls carried away, with varying degrees of "enthusiasm," many different types of objects. In fact, one could say that any alien object tended to be removed—that is, any object not resembling an egg, a chick, or nest material. But we had not yet found out enough to be able to say what characteristics caused the birds to distinguish egg shells from each of these other things.

We knew that they would remove flat cardboard dummies, but nest material (mainly dry marram grass) is also practically flat and yet is not carried away. We decided to offer the gulls flat strips of different proportions. Four types of strips were made, all with a surface area of nine square centimeters, but ranging from squares of 3 x 3 cm. to rectangles of 18 x ½ cm. We found that those of 9 x 1 cm. were carried off most often, and that both the longer and squatter strips were carried less often. Why strips of 9 x 1 were carried more than strips of 1.5 x 2 we do not know, although we have some theories. The very long and thin strips of 18 x ½ cm. elicited interesting behavior. In only 66 out of 280 cases were they removed. Of those not removed, however, 16 per cent were built into the nest. We also made some direct observations from our blinds, and found that the matter was still more complex, for some of the gulls tried to eat the long strips. It is easy to be wise after the event, and we realized that the shape was not dissimilar to that of earthworms—the staple diet of this gull colony.

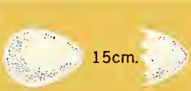
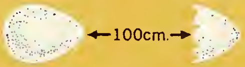
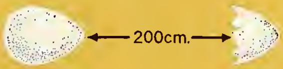
In order to discover how the gulls distinguished between shells and intact eggs we proceeded rather differently. When an egg is presented on a nest's rim, the gull usually retrieves it. The movement is characteristic: the bird stretches its neck, brings the bill down behind the egg, and rolls it into the nest, balancing it against the narrow underside of the bill. This response is not always prompt or complete; it can also misfire if the gull fails to balance the egg properly and loses it before it is rolled in. By direct observation one could notice even incipient responses that could not have been concluded from the position of the egg afterward. Similarly, an egg shell is not always completely removed, but incipient movements can be recognized: instead of bending the head over and beyond the object, the gull may nibble at the broken edge, or may pick it up only to drop it immediately. We wanted to observe all these responses, and therefore our next series of experiments involved watching individual birds from a blind.

In these tests the procedure is frankly anthropomorphic, as indeed it is in all the preceding tests. That is, we first analyze the differences *we* see between an egg and an egg shell, and then try out the gulls' responses to each of these one by one. Now, an egg shell differs from an egg by weight, in having a broken contour when seen from the side, by being hollow, and by having a thin, ragged edge. Since the gull's response can be recognized by us before the egg is touched, the first response must be visual, and weight cannot influence the response at this stage. It was a further lucky circumstance for us that an empty, that is, blown, egg was retrieved as well as a normal one, showing that weight, too, had little, if any, effect on retrieving.

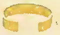
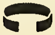
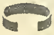
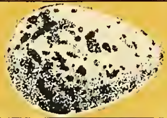
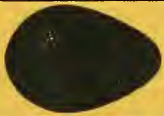
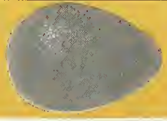
To test whether the broken contour had an effect on the gull, we compared the birds' responses to a true egg with those to an egg shell filled to the rim with plaster. This plaster-filled model did not offer a hollow space or a thin edge, since the plaster adhered exactly to the rim. Both models were always rolled in; no bird ever even nibbled at

		CROW	H. GULL	OTHERS	+TOTAL TAKEN	—NOT TAKEN
WHITE		+14	+19	+10	+43	−26
NATURAL		+ 8	+ 1	+ 4	+13	−55

White eggs proved to be more subject to predation than did those naturally camouflaged. Plus and minus signs indicate numbers of each taken or left.

DISTANCE	EGG ←→ SHELL	TAKEN	NOT
15cm.		63	87
←100cm.→		48	102
←200cm.→		32	118

Predation was much heavier on those eggs that were close to a broken shell. Chart shows varying distances between the two, and the numbers taken or not.

IN NEST ▼	MODELS ▶			
NATURAL		59%	41.5%	28.5%
BLACK		37.5%	45.5%	37.5%
GREEN		38.5%	38%	49%

Percentage of egg shell dummies of three colors removed by gulls that had incubated eggs of the same colors, at the left, shows the effect of experience.

PAPER DUMMY, 18 x ½ cm. in size, was not removed. Perhaps because it was similar in shape to earthworms, a diet staple, this gull attempted to eat it.

the rim of the plaster-filled egg. This meant that the broken contour was, to the gull, not a shell characteristic. When we filled egg shells with cotton wool—which fills the shell, but does not fit exactly to the rim, and so leaves a thin edge visible without, however, leaving a hollow space of any significance—the response was quite different: these models were nibbled at and removed. This meant that the hollowness of the shell had very little effect. It looked as if the thin edge was the principal stimulus. To test this we offered blown eggs as controls, and for comparison similarly intact blown eggs on which was glued about one square centimeter of egg shell, which stood out at right angles from the egg's surface. This model had all the characteristics of a whole egg, but in addition offered a thin edge. No hollow was visible. In two out of every three tests this model was taken by the "flange" and removed; in the other tests it was rolled in. Often a bird alternated between the two responses, showing bits of each in turn. It seemed, therefore, that the thin edge was the main character by which egg shell was distinguished from egg.

THIS, however, raised a new problem. If the birds respond mainly to the thin edge, and not to hollowness, how does it happen that a newly hatched, wet chick, which has not yet fully left the shell, is not removed with the shell? While we do not yet know what characteristics of the chick might play a part, we found that the chick's weight has a profound effect. We gave the gulls egg shells in which pieces of lead that weighed as much as a chick were placed near the pointed end. Such eggs were always nibbled at, but as soon as they were lifted, the behavior simply ended. The bird might nibble again and again, but we never saw gulls remove such shells. This could not be because the bird saw the little piece of lead inside, for even a shell filled to the rim with cotton wool was carried off. The weight alone, therefore, is sufficient to stop a shell from being removed as long as the chick is not completely free. Probably the thin edge of such leaded shells was the reason none was ever rolled into the nest, as was the plaster-filled shell.

Once our interest in this behavior had been aroused, we began observations of egg shell removal patterns in other birds. It struck us that Ringed Plovers and Oystercatchers—which also nest on the peninsula and lay well-camouflaged eggs—removed their egg shells much more promptly than did the Black-headed Gulls. Of ten gulls we observed closely during the whole period of hatching, when there was no outside disturbance, two removed the shell one minute after hatching and one fifteen minutes after. The rest took from one to over three hours. Again we argued: if there is such a premium on removing the shell, why don't the birds do it more promptly, as the waders do? We believe we have found the solution. The Black-headed Gull is a colonial species. It is also a predator, and we found that some individual birds made it a practice to rob their neighbors whenever they could. They are not much attracted to fresh eggs and are, in fact, very inexpert at eating their contents. But pipped eggs and newly hatched chicks are often taken and swallowed whole. However, as soon as chicks are dry and fluffy, the robber gulls seem to lose interest in them. We think that this predation by "rogue" gulls is the environmental pressure that has prevented the parent gulls from removing the shells while the chick is vulnerable. Oystercatchers and Ringed Plovers, being solitary breeders, are not so delayed in shell removal because they do not have predatory neighbors.

Thus we gradually built up a picture of this seemingly insignificant activity. It certainly has survival value, and the analysis of the gulls' behavior revealed how beautifully adapted its control is to the needs. How do gulls acquire this efficiency? Is it "innate" response, or is it learned behavior? We believe that (as is usual with problems of development) the question is too simple.

We have found that on the one hand a gull in its first breeding season removes an egg shell, even if it is presented on the nest's rim before the first egg is laid. An egg presented to such an inexperienced bird is rolled in. It is true that we have so far tested only three such birds, but they responded as promptly and as completely as did more experienced birds.

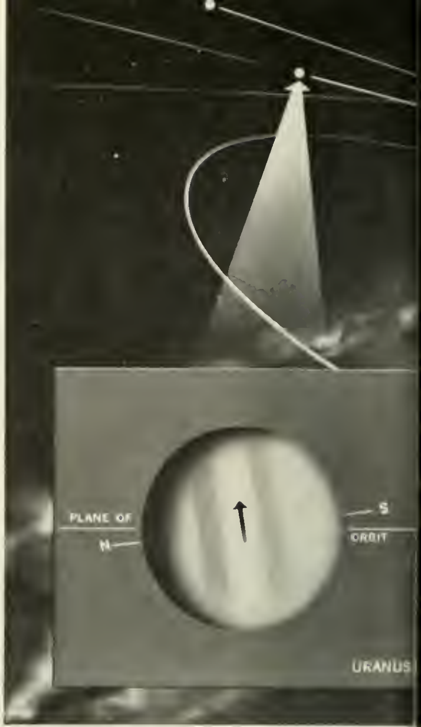
ON the other hand, we also have evidence of learning. We placed three plaster eggs in each of a group of sixty nests. The eggs were painted pitch-black and were introduced into the nests before the birds had laid eggs of their own. Some of the birds deserted; others settled on the dummy eggs. Of the latter, some reacted by laying no eggs at all (a well-known effect of sitting on such dummies); others accepted the black eggs but added some eggs of their own. We removed the real eggs within half a day after they were laid, and were left with a group of fifty-six nests with black eggs. Similarly, we placed green eggs in a group of fifty-three nests. A control group of sixty pairs were left with their own eggs. The birds were allowed to incubate for, on the average, seventeen days. We then tested the responses of all birds to ring-shaped dummies (one of our earlier types) of the three colors involved: black, green, and khaki. We found that the birds that had sat on black eggs removed more black rings than either green or even khaki ones: the "green egg birds" removed more green than either of the other colors; and the controls carried more khaki than either green or black *(page 33, bottom)*. By changing the contents of the nest at the moment of he tests, we made sure that the birds had not been matching the color of the eggs in the nest with that of the ring—hese birds had really learned the color of their eggs during incubation. They showed the same acquired preference in their egg-rolling response, and had transferred this experience to the egg shell removal response.

Even though we cannot claim to have done more than skim the surface of the problem, it is already clear that the control of egg shell removal is extremely complex, and beautifully adapted to the requirements. And yet it is only a minor part of the total set of devices by which these gulls defend themselves against predators. For one thing, there are other aspects to camouflage, such as the wonderfully adapted color glands that, in some unknown way, manage to lay down the pattern of blotching on the eggs; the protective color patterns of the chicks and their ability to crouch in response to the alarm calls of the parents and even to hide under cover; the tendency of the adults to leave their nests at the slightest disturbance and thus, unlike camouflaged birds such as curlews and nightjars, to rely on the camouflage of the brood. But the protection of the brood does not depend on camouflage alone; I have already mentioned the massed attacks gulls make on crows.

Through our work on egg shell removal we have now become interested in the antipredator system of the Black-headed Gull in all its aspects, and we begin to get indications that such things as synchronized laying, the characteristic pattern of nest-spacing, the seasonal and daily rhythms in the selection of the habitat, and several other traits of the gulls are related to defense against predators. And yet, losses through predation are heavy; thousands of young gulls fall victims to crows, Herring Gulls, hedgehogs, and foxes, to mention only the worst of the predators we have seen at work. Our observations on egg shell removal are but the first step in the unraveling of the highly complex relationships that apparently exist between these gulls and their various predators.

Chick has survived the dangerous few minutes that follow hatching. Parent is stimulated to regurgitate food when the young peck at red bill tip. Chicks fall victims to crows, Herring Gulls, hedgehogs, and foxes, among other predators.

Vulcan appears on Leverrier medal.



SKY REPORTER

Uranus, Neptune, and Pluto are relatively recent finds

By SIMONE DARO GOSSNER

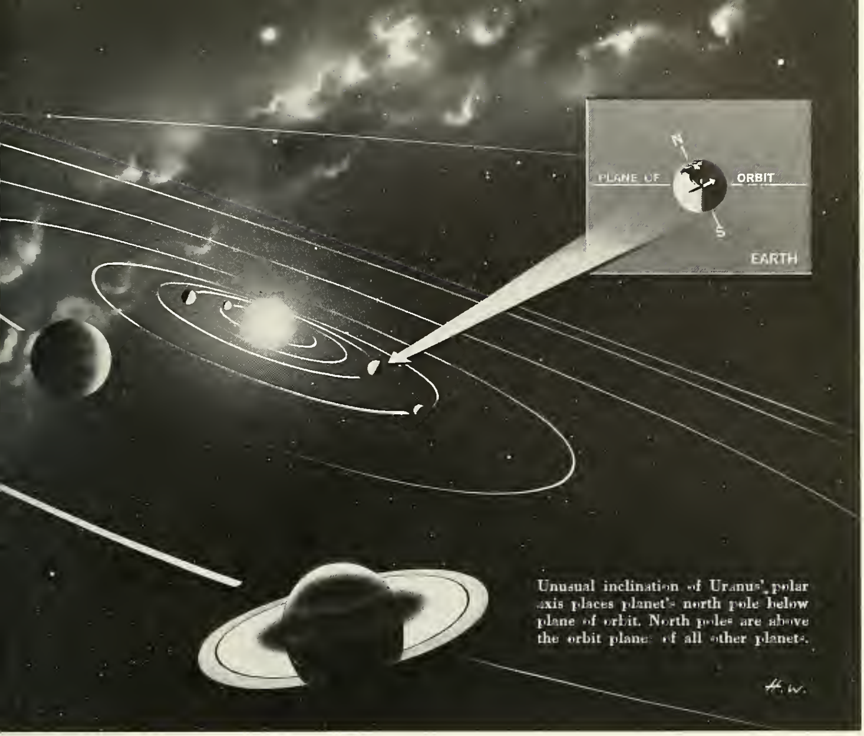
THE ACCIDENTAL DISCOVERY of Uranus by William Herschel in 1781 marked the beginning of a new era in astronomy. Until then, planets had been considered familiar objects, known to observers of the sky since the dawn of humanity. No previous celestial event had intimated that the solar system might possibly extend beyond Saturn, and there is no record indicating that such hypothesis had ever been voiced.

In the years that followed its discovery, Uranus was observed with care and its orbit was calculated with all the precision afforded by the theories of celestial mechanics. But, no matter how painstaking their efforts, astronomers discovered that Uranus was straying steadily and systematically from its computed path. The French mathematician Urbain Leverrier (1811-1877) studied the deviations and concluded that they were caused by the attraction of another planet farther out in space. After elaborate calculations, he determined the position of the as yet undiscovered body. Leverrier communicated his results to Galle, an astronomer in Berlin, who found the planet quickly—very near the place Leverrier had indicated. The new planet, discovered in 1846, was named Neptune.

Heartened by his success, Leverrier turned his attention to another puzzling phenomenon of the solar system, hoping to solve it by a similar method. It had been known for some time that Mercury's orbit rotates in space in unexpected fashion. Leverrier ascribed this behavior to the gravitational attraction of an undetected planet close to the sun than is Mercury. He was so certain of its existence that he even named it: Vulcan, for the Roman god o fire. For several decades, astronomers searched in vain fo Vulcan, until Einstein's relativity theory provided a satisfactory explanation of Mercury's motion (*see* NATURA HISTORY, December, 1961). Vulcan was destined to remai a figment of Leverrier's imagination. His countrymen wer so convinced, however, that when the French Academy o Sciences had a medal struck to honor Leverrier, an appropriate mythological representation of the non-existen Vulcan was included in the medal's design *(above left)*

Soon after Neptune was discovered, astronomers realize that its existence did not explain all the irregularities i Uranus' motion. Leverrier tried again to solve the problem, assuming the existence of another planet beyon Neptune, but he did not finish this project.

Toward the end of the nineteenth century, the questio of a trans-Neptunian planet's existence was reopened b several astronomers, particularly Percival Lowell an William Pickering, both American. Lowell used a metho similar to Leverrier's and based calculations on the remaining discrepancies of Uranus' orbit. Pickering devised semiempirical procedure using irregularities in the motio of Neptune, which had also begun to stray. Both repeatedl issued new predicted positions of "Planet X," but to n avail. The elusive planet—later named Pluto—was finall



Unusual inclination of Uranus' polar axis places planet's north pole below plane of orbit. North poles are above the orbit planes of all other planets.

iscovered in 1930. Its detection was due much more to a ıstidious search than to theoretical calculations.

Of these three modern additions to the solar system, ranus and Neptune resemble the gaseous giants (Jupiter nd Saturn), whereas Pluto is surprisingly akin to the terestrial planets (Mercury, Venus, earth, and Mars).

Uranus and Neptune are almost identical in size, with espective diameters of 29,000 and 28,000 miles and coresponding masses equal to fifteen and seventeen times the ıass of earth. Their rapid rotation (ten hours and fortyve minutes and sixteen hours) causes an appreciable attening at the poles, as in Jupiter. Both exhibit the greenh tinge characteristic of methane in their atmospheres. heir densities are higher than those of Jupiter and aturn. Astronomers accordingly assume a substantial ore of rocks and metals embedded in thick layers of ydrogen and helium.

ONE peculiarity distinguishes Uranus from other planets in the solar system. Its equatorial plane is nearly erpendicular to the plane of its orbit. Therefore its poles e almost in the orbital plane *(see diagram, above)*. Furıermore, if one defines the north pole in the conventional ıanner as that from which the rotation appears counterockwise, Uranus' *south* pole lies north of the orbit (as gainst the north pole for all other planets).

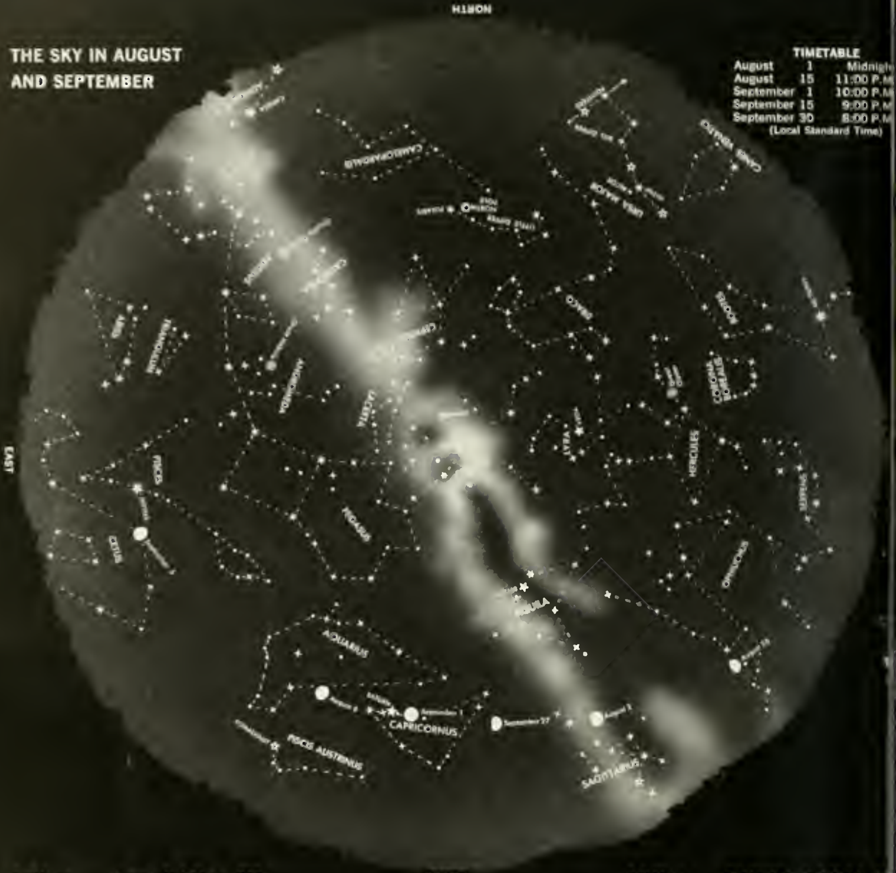
Uranus has five satellites, of which the innermost—and smallest—(Miranda) was discovered in 1948. The other four (Ariel, Umbriel, Titania, and Oberon) are quite large, ranging in diameter from a few hundred to a thousand miles. All revolve in nearly circular orbits, in the equatorial plane of their parent planet.

Only two satellites of Neptune are known at present. The largest, Triton, is about twice as massive as the moon, and revolves around Neptune in a retrograde orbit—that is, it travels against the general direction of motion of most satellites and planets. Nereid, discovered in 1949, is very small, perhaps two hundred miles or less in diameter.

More than thirty years after its discovery, Pluto remains one of the enigmas in the solar system. Its small size, highly elongated orbit, and resemblance to terrestrial planets have led to the widely held view that it is, in fact, an escaped satellite of Neptune. Nearly forty times as far away from the sun as is the earth, Pluto takes 248 years to complete one revolution, but its orbit is so elliptical that it is actually inside Neptune's orbit at its nearest approach to the sun. Calculations indicate that its mass must be nearly equal to the earth's mass. Its diameter, however, measures 3,600 miles at the most. If both these quantities are correct, its density has the incredible value of fifty times that of water, which is heavier than solid gold.

On these pages MRS. GOSSNER presents the seventh in her 1963 series—a co-ordinated review of the solar system.

THE SKY IN AUGUST AND SEPTEMBER


NORTH
EAST
SOUTH
CAMELOPARDALIS
CASSIOPEIA
ANDROMEDA
LACERTA
CEPHEUS
ARIES
TRIANGULUM
PISCES
CETUS
PEGASUS
AQUARIUS
CAPRICORNUS
PISCIS AUSTRINUS
SAGITTARIUS
AQUILA
LYRA
HERCULES
CORONA BOREALIS
BOOTES
DRACO
URSA MINOR
URSA MAJOR
CANES VENATICI
SERPENS
OPHIUCHUS
August 3
September 27
Jupiter
Saturn

TIMETABLE		
August	1	Midnigh
August	15	11:00 P.M
September	1	10:00 P.M
September	15	9:00 P.M
September	30	8:00 P.M

(Local Standard Time)

Full Moon	August 5, 4:31 A.M., EST
Last Quarter	August 12, 1:21 A.M., EST
New Moon	August 19, 2:35 A.M., EST
First Quarter	August 27, 1:54 A.M., EST

Full Moon	September 3, 2:34 P.M., ES
Last Quarter	September 10, 6:42 A.M., ES
New Moon	September 17, 3:51 P.M., ES
First Quarter	September 25, 7:38 P.M., ES

The sun will be at the autumnal equinox on September 23 at 1:24 P.M., Eastern Standard Time. Summer will end in the Northern Hemisphere on that date.

Mercury will be at its greatest eastern elongation on August 24 and at inferior conjunction on September 20. The entire two-month period will be rather unfavorable for observation, because even at the time of elongation Mercury will remain very low in the sky. The planet will set forty-five minutes after the sun on August 1, one hour after on August 15 and 31, and thirty minutes after on September 15. It will enter the morning sky after inferior conjunction and will rise one hour and fifteen minutes before the sun on September 30.

Venus will be in superior conjunction on August 29 and will therefore shift from the morning to the evening sky on that date. It will remain too close to the sun to be seen, except possibly for a period of several days at the end of September. By September 30, the planet will be very low in the western sky at sunset.

Mars will set in the west two and a half hours after the sun on August 1, one and three-quarter hours after on September 1, and one and a half hours after on September 30. At the end of August, Mars will pass about 2° north o the bright star Spica, in Virgo, and will then move graduall eastward into the constellation Libra (+1.6 magnitude).

Jupiter, in Pisces, will rise at 10:30 P.M., local standar time, on August 1, 8:30 P.M. on September 1, and about forty five minutes after sunset on September 30. The planet wi remain visible for the remainder of the night throughout th entire period. It will brighten somewhat from −2.2 magn tude on August 1 to −2.5 on September 30.

Saturn, in Capricornus (+0.6 magnitude), will rise short before sunset on August 1 and at sunset on August 15. Afte the latter date and until the end of September, Saturn wi rise before sunset. It will set at sunrise on August 15, a 4:00 A.M. on September 1, and at 2:00 A.M. on September 3

The most spectacular meteor shower of the year, th Perseids, will reach its peak of approximately fifty meteor per hour (for a single observer) on August 12. This shower visible in lesser numbers for several weeks before and afte the maximum rate occurs. In 1866, the famous Italian astronomer Schiaparelli showed that the Perseid meteors travel i an orbit identical to that of a comet that was seen in 1862

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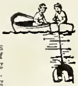

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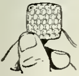

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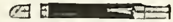

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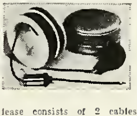

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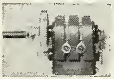

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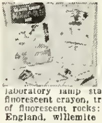

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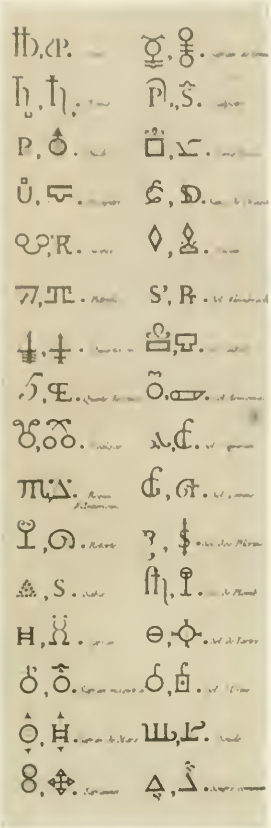
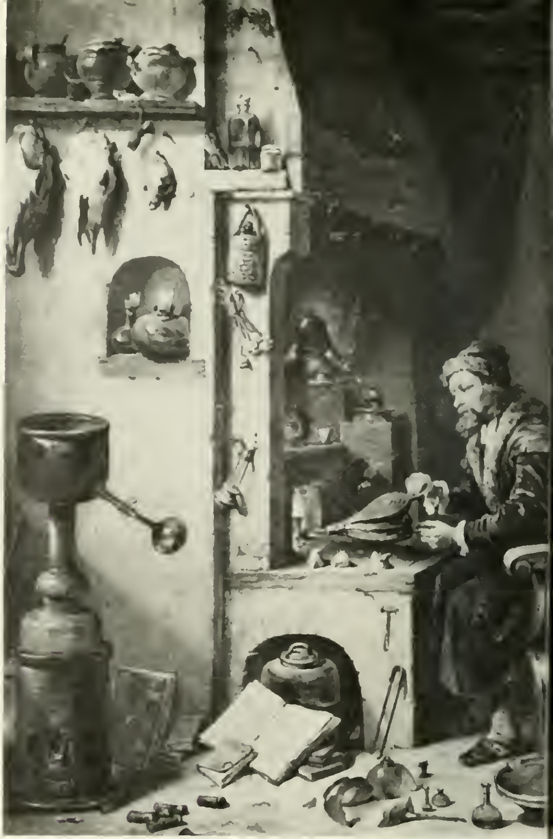




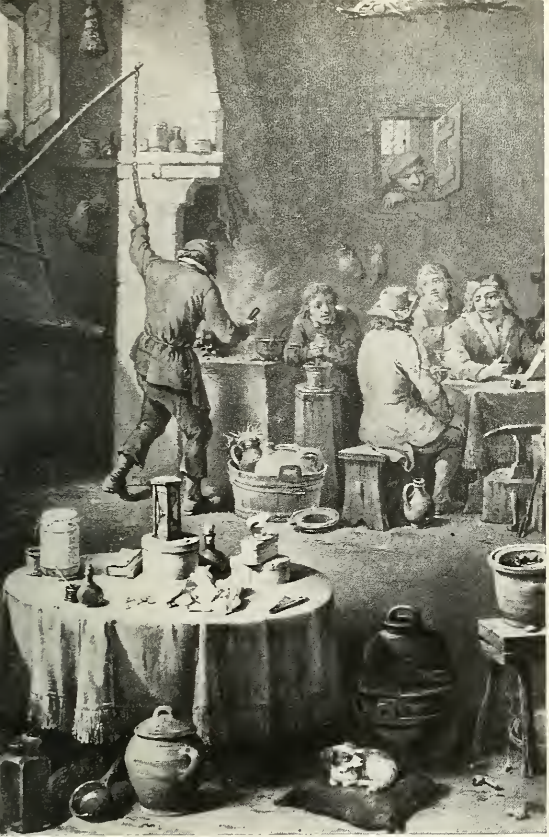
Ancient Art

By David Pramer

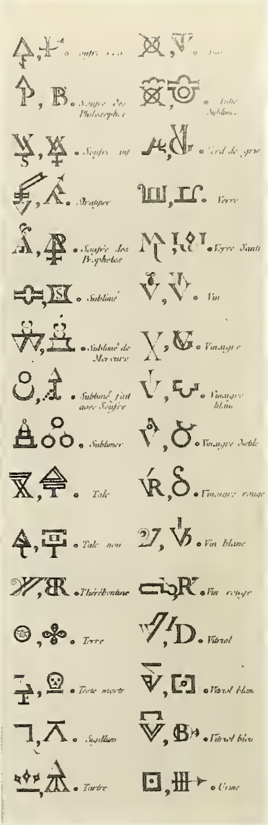
Lord Ernest Rutherford of Cambridge University bombarded nitrogen with alpha particles and changed nitrogen to oxygen in 1919. This conversion of elements justified to some extent fifteen centuries of relentless effort by alchemists—forebears of modern laboratory technicians — who had vainly sought ways to transform base metals into gold. In reports on alchemy, far too much publicity has been given to occasionally infamous abuses by conspicuous charlatans. Too little has been said about the fact that from alchemy sprang both the ideal of the scientific conquest of nature and the laboratory techniques crucial to the rise of chemistry.

Alchemy persisted in western Europe until the seventeenth century, when the development of modern scientific methods challenged its credibility and created fields of inquiry more rewarding — even financially — than the old quest had ever been for all but a very few investigators. Among the last of the practicing alchemists was the great seventeenth-century German scientist Johan Glauber, who died in 1668. Althoug Glauber made his living mainl through the sale of secret chemical an medicinal preparations, he was alread more of a chemist than an alchemis He had determined the exact compos tion of hydrochloric acid, produce sodium sulphate, and prepared variou chlorides by exposing metallic oxid to acid. It is with him, and with h contemporaries, that the science chemistry may be said to begin, an the day of alchemy to near its end.

By Glauber's day, alchemy had ru



Bellows kept the alchemists' fires of transmutation burning, *left*, and won them uncharitable epithet of "puffers."


Soufre des Philosophes
Soufre vif
Stratifier
Soufre des Prophetes
Sublimé
Sublimé de Mercure
Sublimé fait avec Soufre
Sublimer
Talc
Talc non
Thérébentine
Terre
Teste morte
Sigillum
Tartre
Tutie Sublimée
Verd de gris
Verre
Terre Sainte
Vin
Vinaigre
Vinaigre blanc
Vinaigre distilé
Vinaigre rouge
Vin blanc
Vin rouge
Vitriol
Vitriol blanc
Vitriol bleu
Urine

# of Alchemy

a course of more than fifteen hundred years; it had flourished in the chief centers of civilization and had followed the mainstream of learning from China westward to India, the Near East, Alexandria, and eventually to the whole Greek-speaking world. Egypt, or Khem, the country of black soil, has been called the birthplace of chemistry. The Arabs referred to the country as Al Khem, from which the word alchemy was probably derived. (It was not until the eleventh and twelfth centuries, when Arabic texts were translated into Latin, that alchemy expanded into western Europe from outposts of the Moorish Empire then established in Spain.)

Eastern alchemists were the first to practice distillation and sublimation. To do so, it was necessary for them to invent the appropriate apparatus. The most celebrated alchemist of medieval times was the eighth-century Moslem Geber, or Jabir, the Persian-born son of a politically active druggist executed for his involvement in plots surrounding the Arabian caliphate. The young, fatherless Geber attached himself to successive masters sophisticated in the practice of occultism. Eventually, he became an ingenious experimentalist, perfected a technique for purifying substances by crystallization, and described, for the first time, the making of nitric acid.

Geber hypothesized that all metals were composed of two principles that resembled sulphur and mercury. He explained the existence of different metals by the theory that the sulphurous and mercurial principles were seldom pure and did not always combine together in the same proportion. If, on the other hand, they were perfectly pure and combined in the most perfect natural equilibrium, the product would be the most perfect of metals, gold. Defects, either of purity or proportion, could be corrected in the laboratory by the use of elixirs, according to Geber, and developing this method of transmutation became the object of his alchemy. Because of his influence, it became the method of most subsequent alchemical practice.

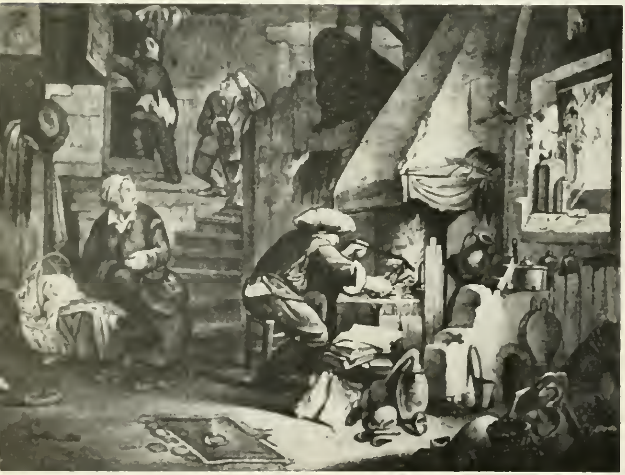
In general, modern chemistry owes to the Moslem alchemists the discovery of many acids. Oil of vitriol, silver nitrate, saltpeter (used in rudimentary gunpowders), the distillation of alcohol, and various medicines that first were valued for their potential as elixirs in transmuting metals, all were introduced through studies by various Moslem scholars.

MUCH about the later European practice of alchemy was covered by a veil of secrecy. Alchemists were usually deliberately vague and wrote so that others could never hope to understand them. They pretended that what knowledge they possessed was handed down directly from the ancients. This obscurantism was based on a cultural and intellectual bias, stronger then than now, for valuing things in proportion to their antiquity. Usually, the alchemist did not attempt to advance his work by discovery, but was more interested in rediscovery and in placing a new interpretation on the writings of those who had preceded him. Consequently, he wished his own works to appear ancient, and used names at the head of his treatises that in many cases were obviously false, such as Isis, the Egyptian goddess, Moses, Cleopatra, or that of a deceased or famous alchemist, like Geber. The titles of some alchemical books today seem unnecessarily mystifying: *The Stairway of the Sages; The Magnum Opus Unveiled, for the Benefit of the Children of Light;* and *Morbific Hydra Exterminated by Chemical Hercules* are typical of these.

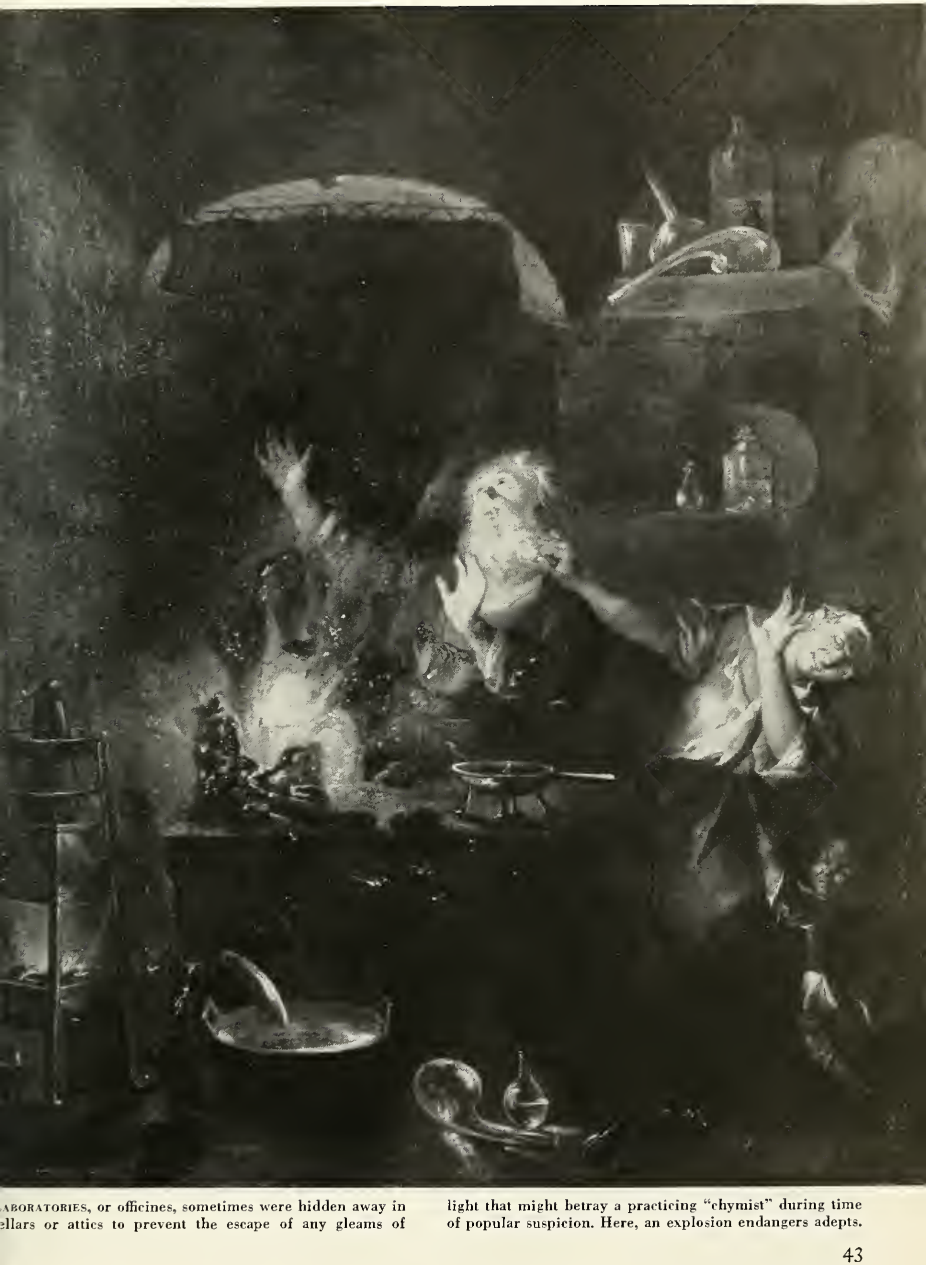
The modern conception of an alchemist is that of a rather unattractive, old charlatan who devoted his time to a meaningless search, and who was peripherally a magician or a wizard. On the whole, this is quite erroneous. Of course, there were some charlatans or practitioners who suffered delusions. For instance, Nicholas Flamel, the late fourteenth- and early fifteenth-century Parisian adept, claimed to have been directed by an angel to a magic, holy book written by "Abraham the Jew, prince, priest, astrologer, and philosopher." Accredited by his contemporaries with discovery of the "philosopher's stone" — a laboratory-created catalyst of great purity capable of effecting transmutation—Flamel became wealthy enough to support sev churches and endow fourteen hosp tals. As late as the eighteenth centur the Comte de Saint-Germain claime to have discovered an elixir of life an to be more than two thousand yea old. He died in 1781. Albertus Ma nus, one of the first Western schola to engage in alchemical research, e posed charlatans, yet it was onc rumored that he himself had used philosopher's stone to pay off the deb of his bishopric. Saint Vincent d Paul, describing his captivity amon the infidels in Tunis, wrote how on old man, a local "puffer," fused thi silver and gold sheets in forges, an also congealed quicksilver, "which h sold so that he might give alms. . . .

But regardless of misconception the sincere and devoted practitione seldom, if ever, employed magic charms or spells. Rather, he sought t accomplish his work by uncoverin and using the laws of nature. Parace sus, the eminent early sixteenth-cen tury physician, described the devotio and single-mindedness of the hone alchemist when he wrote: "These d not give themselves up to ease an idleness, strutting about with haughty gait, dressed in silk, wit rings ostentatiously displayed on thei fingers, or silver poignards fixed o their loins, and sleek gloves on thei hands. But they devote themselve diligently to their labors, sweatin whole nights and days over fiery fu naces. These do not kill the time wit empty talk, but find their delight i their laboratory. They are clad i leathern garments, and wear a girdl to wipe their hands upon."

TO appreciate the working alche mist it is necessary to examine th science of his times. His ideas wer concerned with generation. The mos influential analysis of matter was tha made by Aristotle in the fourth cen tury B.C., and on which Geber elabo rated a millennium later. Aristotl believed all things could be divide into essence and matter. Matter was composed of four elements: heat, cold wet, and dry. With time, essence itsel came to be regarded as a fifth element —hence the term quintessence. Earth was cold and dry, while air was warm and moist; fire was hot and dry; water was wet and cold. The Aristotelian concept that there was an ultimate essence that could take an infinite number of forms was of primary im-



PHILOSOPHICAL FIRE of a metalworker had to be "vaporous, digesting, non-violent, enclosed, airy . . . continuous, obstructing, corruptive," wrote adepts.



ABORATORIES, or officines, sometimes were hidden away in ellars or attics to prevent the escape of any gleams of light that might betray a practicing "chymist" during time of popular suspicion. Here, an explosion endangers adepts.

portance and carried weight for many centuries. As Geber was to reason, if any substance could be reduced sufficiently, its essence could be freed and incorporated in the new form of another substance through a controlled blending with other essences.

The *materia prima* of the alchemists thus evolved from Aristotle's quintessence. *Materia prima* was present in all things, but it was always contaminated, in Geber's theory, by impurities. These the alchemists hoped to remove by processes of purification, especially by fire. If it could ever be obtained, alchemists believed *materia prima* would work wonders of many kinds. It would change the baser metals into gold by contact, heal all diseases, and would even regenerate the character of the discoverer.

In addition to *materia prima*, alchemists generally recognized Aristotle's four elements. They frequently added or substituted others of their own, particularly mercury, sulphur, and salt, indicating that they did not mean the substances commonly known by these names, but rather the mercury, the sulphur, and the salt "of the sages." Mercury seems to have symbolized the metallic principle inherent in all metals, as well as the volatile forces necessary for generation; the mechanism of transmutation was frequently referred to as "fixation of mercury." Sulphur represented the property of combustibility, and salt stood for earthy properties, notably resistance to fire. In Geber's words "all metals are in their essences mercury coagulated with sulphur . . . and they differ only on account of their differential accidental qualities."

To obtain the essence of, let us say, copper, the metal was frequently heated with sulphur, lost its metallic properties, and became a black mass. The problem of the alchemist was how to transform the essence of the blackened mass to make something utterly new come into existence. It was for this purpose that the alchemist turned to the heavens. From earliest times planets had been associated with metals, and the same astronomical signs were commonly employed for both. The sun stood for gold, the moon for silver, Jupiter for tin, Saturn for lead, Mars for iron, Venus for copper, and Mercury for the metal of the same name. It followed that when a metal was to be acted upon, it was vital that its patron planet be rightly situated.

Yet alchemists had no idea that there existed one and only one definable metal called gold. As Geber believed, so did most others: all sorts of gold existed, for was not pure gold itself merely the most perfect combination of the sulphurous and mercurial principles? Pure gold thus was at the end of a continuum including less perfect golds, as well as baser metals like silver, lead, tin, iron, and copper. How did the alchemist know if his final product was, in fact, pure?

Pure gold was shiny, heavy, yellow, untarnishable, and fire resistant. Although experimenters had no recourse to chemical analysis, two tests were frequently applied—that of the touchstone and that of fire. In the former, gold was rubbed on a hard black stone and its quality was judged from the character of the streak produced. In the case of the test by fire, pure gold, however long it may have been heated at the relatively low temperatures in an alchemist's oven, would have remained substantially unchanged, although some allowance would have had to be made for inevitable oxidation. But while the test by fire ruled out alloys of base metals with low melting point temperatures, like lead, this same test was not precise enough to detect harder alloys. Crude gold, even modern jeweler's gold, will be affected by prolonged heating, because it is almost always alloyed with copper.

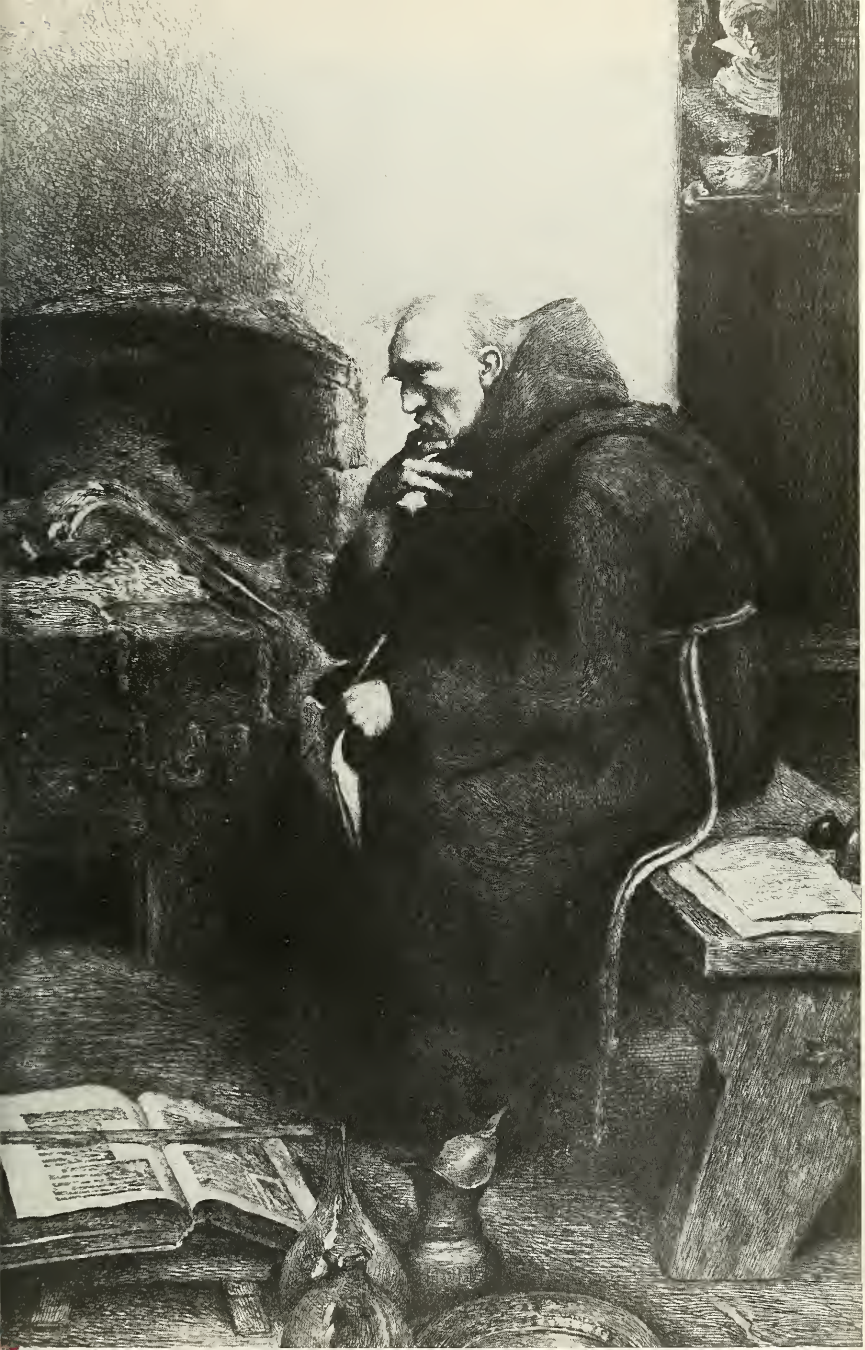
The heavy density of gold was known from the time of the classical Greeks, but it is doubtful that measurements of specific gravity were made. The experienced alchemist certainly must have employed his expert's delicacy of the senses, and rejected anything that, in addition to undergoing the tests of touchstone and fire, did not feel or look quite right.

It would be an oversimplification to say that alchemy developed into chemistry, although great alchemists made numerous discoveries that helped lay the foundations of chemistry. Albertus Magnus obtained arsenic regulus by heating arsenious anhydride; Paracelsus discovered that zinc was an element; Basil Valentine discovered antimony; while a series of other "chymists" produced such specifics as acetic acid, lead acetate, tin tetrachloride, medicines, oils, soaps, and even dentifrices. These, however, were merely by-products of a common and
overriding quest—the attempt to re
ize perfection, especially of meta
Alchemy's method was, primarily,
proceed from the dictates of ancie
texts, although it also included refle
tion upon nature and specific expe
mentation as demanded by given
chemical problems. On the other han
chemistry, beginning with observ
tion, attempts to measure and descri
matter's properties in order to discov
general laws. There is no single ince
tive of enough force to cause the d
tortion of objective inquiry. To t
contemporary empiricist, books a
merely storehouses of informati
not authorities; conclusions must
backed up by experimental eviden

The factor common to alchemy a
chemistry is obviously that of tec
nique. The alchemists were the fi
laboratory workers and so develop
the apparatus and methods needed f
the separation and reaction of vario
substances. Chemistry began when t
alchemist's apparatus and techniqu
passed into the hands of those w
had as their objective something oth
than the transformation of base met
into gold. Still, there is nothing inh
ently absurd in the problem that t
alchemists set themselves. It is ch
acteristic of nature that one substan
with certain properties disappea
while another with different propert
takes it place. There was nothing
the knowledge of the alchemists' ti
that indicated the impossibility of
taining gold from copper or lead. T
only way to find out was to try.

The alchemists did try, with en
less patience, and their efforts we
not wasted. Roger Bacon, the Franc
can monk controversial in his day f
strongly stated opinions, typified t
scholastic of thirteenth-century Euro
in that he involved himself in ma
disciplines, including alchemy, optic
calendar reform, meteorology, a
philosophy. To Bacon is attribut
one of the most accurate insights in
the dominant science of his tim
"Alchemy may be compared to t
man who told his sons that he had l
some gold buried somewhere in h
vineyard: where they by diggi
found no gold, but by turning up t
mould around the roots of the vin
procured a plentiful vintage."

Roger Bacon, known to successors
Doctor Mirabilis, was a churchman, a
alchemist, an experimenter in optic



New Theory on a Fabled Exodus

Endocrine malfunction may cause lemming psychosis

By Kai Curry-Lindahl

"Lemming migration," "Multitudes of lemmings," "Wells at X-ness full of lemmings," these were some of the headlines that caught the eye of the Swedish newspaper reader at regular intervals during 1960 and 1961.

What were the real facts behind these headlines? Was Lapland truly inundated with lemmings? Was there a dense carpet of these small rodents pressing irresistibly from the mountains toward mass suicide in the sea?

For centuries, stories about the Norway lemming *(Lemmus lemmus)* have spread over the world, far beyond the limits of its habitat. In 1532, Ziegler of Strasbourg published a treatise on the lemming, based on information obtained in Rome from two bishops from Nidaros in Norway. He related that in stormy weather lemmings fell from the sky in enormous numbers, that their bite was venomous, and that they perished by thousands when the grass began to grow in the spring. In the chronicles of the march of King Charles XII's soldiers over the mountains between Jamtland and Norway in August, 1718, Jöran Norberg wrote, "People maintain that the clouds passing over the mountains leave behind them a vermin called mountain mice or *lemmings* by the inhabitants; in size they are as big as a fist, and they are furry, like the guinea-pig, and poisonous." The same legend of the cosmic origin of the lemming is also found among the Eskimos, whose name for one Alaskan species means "the creature from space."

The Norway lemming is found in all parts of the Scandinavian high mountain range, as well as in the highlands of northeastern Swedish Lapland and in Finland. Lemming population rises periodically, some years to enormous numbers, in all the vegetation belts of the mountains; in the intervening periods it is very low.

Norway lemming has a glossy coat and is a bit larger than our field mouse.

In most parts of the mountains, the spring migration of lemmings during a "normal year" (not an "eruption year") need not cover great distances toward lower altitudes; winter and summer quarters are generally close to each other, usually in the same belt of vegetation, most commonly above the willow region. Thus, above an altitude of 2,500 to 3,300 feet, migration is generally horizontal.

In summer, lemmings seek shelter in natural depressions and cavities in the ground, or make tunnels in the ground vegetation. Such refuges, which are often no bigger than the animal itself, are used regularly, and depending on the condition of the ground, the lemmings' paths can be discerned in the carpet of lichen.

From May to August, the animals prefer to inhabit moist, stony ground partly covered by sedges *(Carex)*, willow shrubs *(Salix)*, and/or dwarf birch *(Betula nana)*. Such habitats provide the animals with food and the hiding places necessary for survival in an area of many predators—the stoat, or ermine, the weasel, the rough-legged buzzard, the common raven, the long-tailed skua, crow tribe, and snowy owl. Water does not seem to inconvenience the lemming during summer, for its fur is water repellent, and the animal behaves almost as if it were aquatic. However, it needs dry holes for reproduction, as the newborn young are sensitive to moisture and cold.

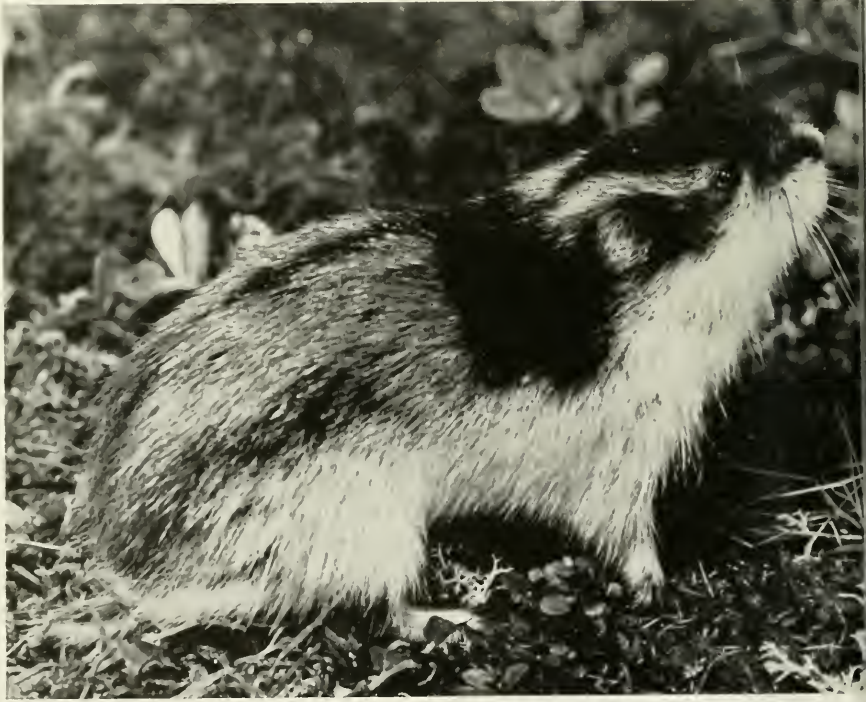
The situation is quite different in winter. In autumn a move starts for drier places, because in the winter damp ground combined with severe cold can mean death for the adults as well. The lemmings can usually live in comparative safety under the snow, which protects them from cold and from enemies. If rain and frost should blanket the vegetation with an ice sheet before the snow cover is established, however, the result for the animal may be fatal, as food-gathering then becomes a serious problem.

Although many summer predators are completely absent in winter, the stoat and weasel hunt under the snow. They are the lemmings' only important enemies in wintertime, and even these are relatively rare in the lichen region during winter. Thus, the lemming population above timber line is practically free from predation until early spring, when the lemmings first venture above the snow. Beneath the snow, lemmings construct extensive passages and build round nests of grass that are sometimes attached to willow shrubs, and may be seen hanging on twigs after the snow melts.

During an ordinary winter, without unusual vacillations in climatic conditions, the rodents take advantage of their protected situation to breed. The lemming is so prolific in some years that, in view of our experiences in 1960 and 1961, which I will go into, I am inclined to suspect that winter breeding is a necessary condition for a subsequent population peak. This is a unique situation among rodents, in the light of present knowledge, although we have found some indications that the field vole *(Microtus agrestis)* may also breed in winter. In Scandinavia, the lemming may have survived in some refuge areas during final Ice Age glaciations. If the animal entered the Ice Age much as it is now, then its ability to breed under the cover of a snow blanket would

Mountain heaths provide a favorable winter habitat. Lemmings live under the snow, where they excavate tunnels and breed protected from predation.

Seasonal migrations occur betwe biotopes. In peak years, the lemmin



Rodent's fur is water repellent. In famous migrations the animals will cross almost all obstacles in their paths: hills, streams, lakes, rivers. Adept as they are, mishaps ofte occur when they try to negotiate insurmountable barrier

nove from mountain heath to conifer elt, and still lower, warmer regions.

Lichen belt stretches over northern Scandinavia, Finland, and U.S.S.R. In winter, lemmings feed under snow. A lichen-covered meadow, *above*, thaws.

bviously have favored it. On the other and, its specialization may have de-eloped only after the onset of the ce Age in its habitat.

FOR centuries people have speculated on the reasons for the rapid ncrease of lemmings. The explanation s probably that the species, hidden rom view from autumn to spring, is ble to build up several generations n a single season. But why does the emming manifest such marked popu-ation increases in certain years? In ddition to a high breeding potential, ertain environmental factors are in-erent in a population explosion:

(1) Generally favorable climatic onditions, which in turn affect both he supply of food and the ability to ake advantage of it during a great art of the year, and permit survival f the young in their passive period in he nest. Early springs and late au-umns would therefore be propitious.

(2) Proper climate during the win-er periods when newborn young are n the nest. Mild weather and thaws ay then be fatal, and it is possible hat severe cold has the same effect.

(3) The almost complete absence f predation pressure in winter.

But if the long winter and the lanket of snow are so advantageous, s claimed above, how, then, can early prings and late autumns also be fa-orable? The fact is that the supply of ood beneath the snow is limited, so that the idyl there may become a fatal trap if it lasts too long, particularly during the years when lemmings are most numerous. It is very likely that this trap snaps rather often—one explanation as to why population explosions occur only infrequently.

As mentioned above, the seasonal migrations of lemmings from one relatively nearby biotope to another are not the same as the dramatic marches that have made lemmings so famous. In the light of 1960-61 investigations, when there was an eruption of Norway lemmings, it seems that the populations normally move within their natural biotopes—the extensive mountain heaths in the lichen belt, downward to willow, birch, and conifer regions, from whence they disperse overland.

These less noticeable vertical movements of lemmings flow, as it were, slowly down the mountain slopes. Individually the movements seem to be at random—a straying in different directions, both high in the mountains and lower down. Breeding continues during these movements, but females that are in an advanced stage of pregnancy settle at whatever level they may be, even when far away from the lemmings' most favorable and densely populated habitats, which lie high up on the mountain heaths.

It is probable that the lemmings were on the move throughout practically all the summer months of 1960, but their movements were individual and scattered, which made it impossible to determine direction, speed, and the number of animals taking part. It was clear, however, that three waves of lemmings flowed downward from the upper vegetation belt into the conifer forest. The first was at the end of May, when the animals began to appear or to increase greatly in numbers in the upper coniferous tracts on both sides of the mountains that lie between Sweden and Norway.

A new wave became noticeable about a month later. This rise in the population was clearly due both to on-the-spot breeding and to the arrival of lemmings from higher altitudes. Finally, a third wave broke over the conifer belt at the end of August and September, in some places as late as October. In the last case, too, the frequency peak was probably combined with breeding activities.

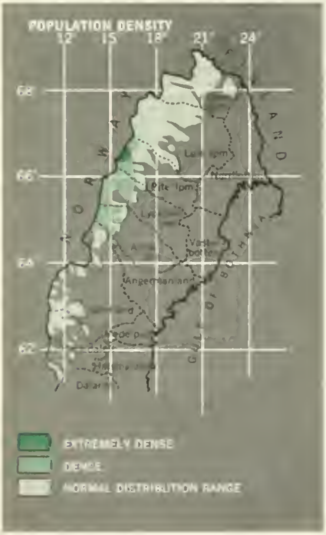
THE mass migrations, on the other hand, seem to occur only in certain topographical situations—if a long lake stops the rodents' slow, almost invisible progress, or two rivers meet and the lemmings are, so to say, caught in a funnel. In these and similar situations, there is a continuous accumulation of animals. Finally, the concentration is so great that a certain panic reaction results—a kind of mass suggestion. This is expressed in a reckless march that need not follow any special direction, but may go north, south, east, or west, uphill or downhill, over rivers and lakes, and sometimes to the sea—particularly in Norway, where the mountains are close to the shore. The march may also go from the mountain heaths up over the glaciers. Thus, a panic-stricken flight in the form of a mass migration may begin up on the mountain heaths, but there, too, overpopulation seems to be the main cause. There is much evidence to suggest that the eliciting factors of mass migration are a kind of psychosis, possibly owing to the competition with other individuals for sheltering holes and territory, but not, as far as is known, for food; even when lemmings are most numerous, food is available in the vicinity.

It is quite possible, however, that the food of the Norway lemming is far more specialized than has hitherto been believed, and if this is so, lack of suitable food may be of decisive importance. Diseases also have been advanced as one explanation for the mass migration phenomenon, but migrating populations have not been too ill to settle again and breed in new territories. In addition, many animals remain in their original habitat. The idea that lemming migrations always end with death is therefore erroneous, as is the fanciful belief that they form a dense carpet of moving bodies during mass movements.

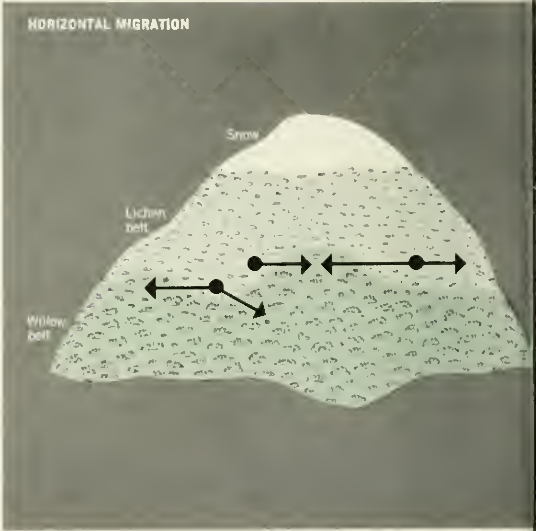
In the New World, it has been found that during a peak year vegetation has been completely devoured locally, and this is believed to have caused mass movements. But migration of the North American species—the brown lemming *(Lemmus trimucronatus)* and the collared lemming *(Dicrostonyx groenlandicus)*—is unusual and irregular, and cannot be compared to the periodic migrations in the Fennoscandia region. While in the latter area the movements of lemmings and their dispersion over great areas reduce the risk of food shortages, it is not yet known whether any special plants in the lichen region are of particular significance for the animals' health and well-being. If it should be discovered that certain plants are vital, their decrease during peak population years might well be a prime cause of migration. Perhaps a prolonged lack of a certain vegetable food in the diet contributes to endocrinological disturbances and the unexplained mass deaths to which lemmings are subject.

An interesting situation existed a
the end of July, 1960, in the con
fer region along the River Graddielv
in Norway, west of the mountains o
the Pite lappmark area in Sweden
There were swarms of lemmings. The
were particularly numerous on a nort
slope that angles down toward th
river, and is close to the junction o
two watercourses. Tunnels and nes
holes were everywhere in the mos
and there were large, collective heap
of excrement. Well-trodden miniatur
paths, like small canyons worn in th
moss vegetation, formed a dense net
work. Even during the hottest hour
of the day (in a heat wave), with tem
peratures up to 88 F., a number o
Norway lemmings were active; the
were only a minority of the enormou
numbers that infested the place durin
the cooler evening and night. In th
daytime most lemmings remained i
the holes that were at their disposal
while at night the animals sometime
congregated in great flocks along th
bank of the river.

Many individuals swam across, bu
the majority hesitated. They ran u
and down along the shore; some threw
themselves into the water but the
turned back at once. Obviously, mos

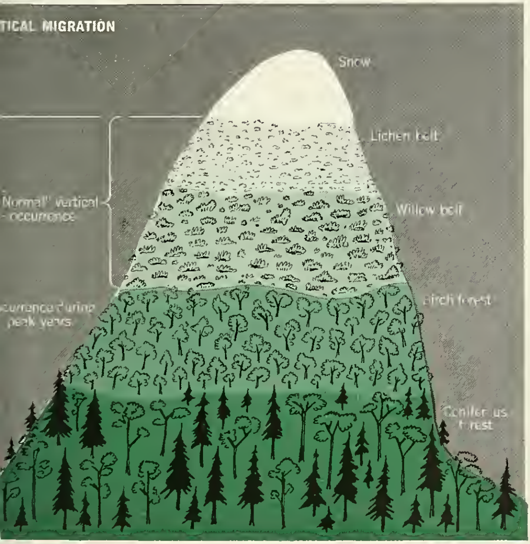


Distribution of Norwegian lemming in Sweden is shown with 1960 densities.

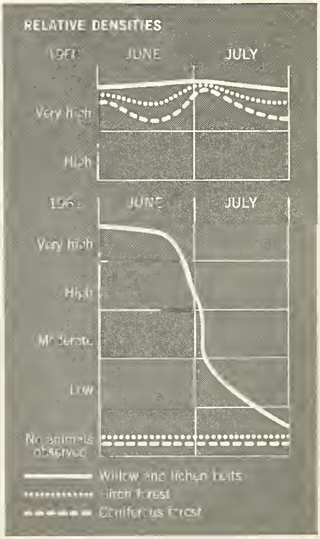


In a non-peak year, movement of the lemmings is typically horizontal and at more or less fixed altitude in a situation of low population density.

HREE-PLUS YEARS is a natural old age for the survivors of redation or disease; but many of the lemmings probably do not die of old age, succumbing instead to pathological conditions that seem to effect sudden population crashes.


TICAL MIGRATION
Snow
Lichen belt
"Normal" vertical occurrence
Willow belt
currence during peak years
Birch forest
Coniferous forest

EAK YEAR migrations are vertical. t those times, animals move down in the biotopes, overflow from each and increase in numbers as they descend.



COMPARISON of two years shows that crash was completed in July of 1961.

had not been affected by the innate urge that would probably soon start the living avalanche on its way.

Lemmings swim very fast, with their heads held high. Sometimes they try the current in different places before they finally set out. They often swim diagonally against current until eventually they reach the opposite bank. Occasionally, one jumps up on a stone in the middle of the stream and rests there. During the swims in the Graddielva there was no question of a panic-stricken flight, for the lemmings crossed one by one and almost invariably only after they had carefully chosen a suitable spot for the crossing.

In spite of this seemingly cautious behavior, it was clear that the population was in a state of constant tension. The restlessness may have occurred because the habitat was not ecologically optimal for an Arctic animal, and because it was overpopulated. It is likely that the process toward an acute psychological tension was developing, but the threshold value that would release mass migration had not yet been passed. As usual, the calm behavior of the pregnant females contrasted with the feverish nervousness of the other lemmings. The former were methodical and purposeful: although surrounded by the chaos of their rushing, jostling, screaming kindred, they always knew where to find their holes, into which they slipped at the first sign of unusual disturbance or danger.

UNFORTUNATELY, I could not stay in this region to see the outcome, but a report from a local observer informed me that three days after I left, practically all the lemmings were gone. The majority had crossed the rivers, but a few had been observed moving back in the direction from which all had previously come. If the observations are correct, the last feature is particularly interesting because it is an indication that lemmings do not necessarily move in their initial direction, which is generally downward. They can also return upward.

At this stage there was no sign of any population crash—another phenomenon connected with lemmings. A drastic and sudden decline of the population almost always follows a peak year. If there is no doubt that predation is often important in keeping populations of small rodents in check (as Frank Pitelka and his associates from the University of California in Berkeley have shown to be the case in Alaska), on the whole the population size for such animals seems to be regulated by a complex of factors (including predators), in combination with self-regulating mechanisms. The Norway lemming is a striking example of this. If neither predators nor food plays a decisive role in the fantastic Norway lemming population crashes, which are almost without parallel in the vertebrate world, what is the cause of their wholesale deaths?

In the first place, every Norway lemming must die sometime, and it does so within the four-year cycle that characterizes the periodicity of the species, for the known life span is less than four years. But the majority of Norway lemmings probably do not die of old age. The strange, abnormal features of their behavior during "explosion years" has been mentioned earlier. Such pathological phenomena, with mass death in their wake, may also appear in extremely dense populations of other species of small rodents before a fatal lack of food arises through overcrowding.

Unfortunately, the physiological

nd microanatomical phenomena, par- icularly those concerning glandular nd metabolic interrelations, have ever been examined in detail in *emmus lemmus*. Recently, however, number of significant features in the ndocrine organs of the collared lemming have been described by W.B. uay at the University of California n Berkeley, who has advanced the ypothesis that in warm and/or stressul conditions, a metabolic derangement occurs that is conducive to bnormal deposits of colloidal maerial in the walls and lumina of small blood vessels of the brain, including the hypothalamus. The condition has been found in feral collared lemmings during two summers at one of the southernmost outposts of the species, and suggests that the described phenomenon may be significant in affecting natural populations.

Quay's conclusions are highly interesting in relation to the fact that manifestations of great physiological imbalance in *Lemmus lemmus* are more often expressed by individuals that occur in summer in lower and warmer areas, to which the species is less adapted and to which they have been forced by population pressure in upper, optimal habitats.

The physiological picture of what happens in collared lemmings living in warm or stressful conditions does not seem to exclude the theory that other physiological factors are also involved. The view that the disfunction of the pituitary seems to result in an overproduction of the adrenocortical stimulating hormone, which in its turn overstimulates the adrenal function in such a way that the production of corticoid hormones first increases and then reaches a stage of complete exhaustion, does not seem to be antithetical to Quay's results and suggestions. The metabolic derangement found by Quay is probably only a preliminary phase to the physiological collapse that precedes the breakdown of adrenal function, which in its turn causes the death of large numbers of lemmings and explains the sudden crash of the whole population.

IT is not known whether the causes of population crashes, simplified and described briefly here, hold good for the Norway lemmings. During the autumn of 1960, however, dead, intact lemmings were often found. There was a pronounced population decline at the end of that year, but the crash did not appear to be associated with either lack of food or predation, but rather with a physiological imbalance.

However, the whole population did not crash in 1960. We had expected a continuous decline during the winter, but in May and June of 1961, to our surprise, we found dense populations in several areas. Apparently the high was locally still in full swing. Then the situation changed drastically, and in the last two weeks of June most lemmings disappeared. The interesting point was that they did not leave their areas by migration, nor were they considerably reduced by predation. They just gradually vanished on the spot, apparently dying in their shelters and holes, where, after some digging, we found carcasses which, unfortunately, we could not study pathologically.

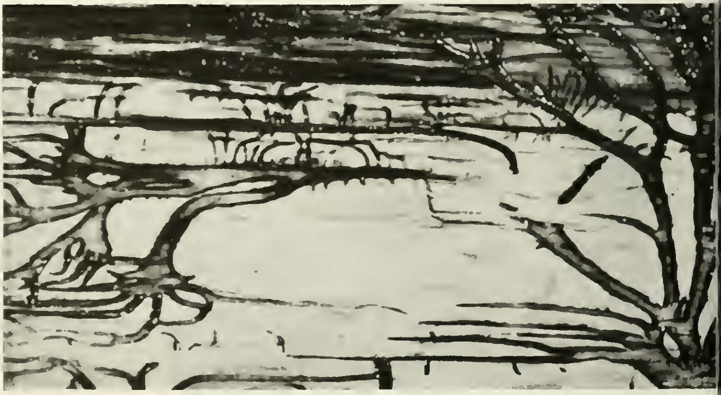
Further chemical research will undoubtedly produce answers to some of the fascinating and often dramatic behavior of these remarkable rodents.

SUMMER BREEDING occurs, but winter cover is essential for peak increases.

TRACINGS made by colonies of Douglas-fir beetles in an inner section of the fir's bark are shown here and below in an unusually clear and aesthetic pattern.

Engravings Beneath the Bark

Beetle's cycle is seen in egg galleries



By Marjory M. Fisher

With tongue in cheek, it might be said that in highly art-concious Seattle, a remarkable beetle has early cornered the market on impresionistic wall plaques. When I first saw picture panel in a Seattle art shop ecently, I thought it a most unusual ngraving of a landscape executed by n artist of sensitivity and deft skill. nformed that the delicate engraving as the work of "bugs or a fungus of ome sort under tree bark," I hardly elieved it and sought proof.

I soon learned that the first plaque as discovered in an Everett, Washngton, lumber mill by a young workan named Allan Potter, who rescued n engraving in the debarked trunk of fir as it passed from the edger to the aws beyond. In the lumber mill, and in ubsequent investigations, I found that otter's discovery was probably the ork of the Douglas-fir beetle and sevral other beetle species that are part f the large scolytid family of woodoring insects known generally as enraver beetles. The Douglas-fir beetles re found wherever the trees grow—in e Pacific Northwest from the north d of Vancouver Island in British olumbia, through Washington and regon, down the Coast Range to anta Cruz, California; along the ascades and Sierra Nevadas to the an Joaquin River in California; in e Rockies from Canada to Mexico.

The family Scolytidae is extremely estructive. The U. S. Department of griculture once stated that if the timber destroyed by Scolytidae in the United States during the past fifty years were alive, its stumpage value would be more than one billion dollars. In 1935, the Douglas-fir beetle alone destroyed three hundred million board feet of green fir timber; the epidemic resulted because two years earlier forest fires had damaged a large area of firs, creating a highly favorable breeding ground in which the beetles could multiply.

The tracings Potter discovered in Everett were probably the work of the following species: *Dendroctonus pseudotsugoe* Hopk., *Scolytus unispinosus* Lec., *Pseudohylesinus nebulosus* (Lec.), and *Pseudohylesinus grandis* Sw. But whatever the species, their "masterpieces" are purely autobiographical, illustrating a life cycle.

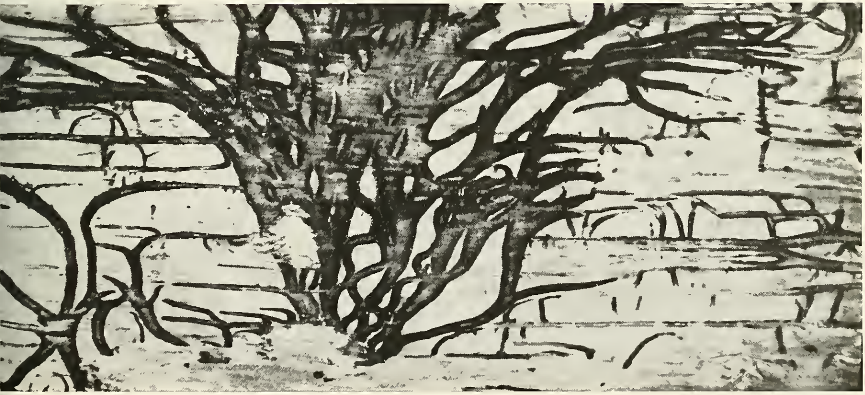
Dendroctonus pseudotsugae, the species that probably made the designs in the photographs, is commonly called the Douglas-fir beetle. It is about one-fifth of an inch long, cylindrical, and rather stout—slightly smaller around than a matchstick. The adult beetles range in color from reds to dark browns to blacks, usually with reddish-brown wing covers. It is a monogamous insect, and the mates work in pairs, led by the female. They enter the tree and construct egg galleries from six to thirty inches long in the inner bark. Occasionally, they also etch the sapwood. The egg galleries of this species are usually straight or slightly sinuous.

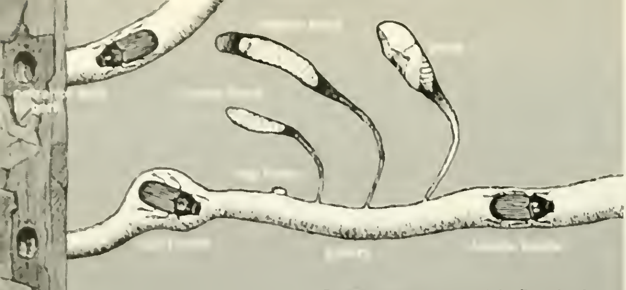
Douglas-fir beetles carry spores of a blue stain fungus (*Ceratostomella pseudotsugae* Rumhold). If either the fungus or the beetles completely encircle the tree and cut off the food supply in the cambium layer, the tree will die. (Most engravers are carriers of fungus. A relative of the Douglas-fir beetle, *Scolytus multistriatus*, introduced from Europe, is considered a prime carrier of Dutch elm disease.)

Douglas-fir beetles lay eggs in masses of from ten to thirty-six in the grooves along alternate sides of their galleries. In about fifteen days the eggs hatch into larvae, which mine between the bark and the wood at right angles to their egg gallery, widening their tunnels as they themselves grow in size. Thus, the designs on plaques appear thin near the larval origin and wider toward the edges of the engraving. The completed work is somewhat fan-shaped. When the larvae are full-grown, about sixty-five days after hatching, they excavate pits where they pupate.

These pupal cells, at the end of the mines, may or may not be exposed when bark is removed from a tree, depending on the bark's thickness. The pupae usually metamorphose into new adult beetles in about a week. These then often congregate for fairly long periods beneath the bark before boring through it to emerge and attack other trees. A tree that has harbored the beetles can often be identified by the "bird shot" emergence holes.

One generation a year is thought to be the normal rate of reproduction of *D. pseudotsugae*, but the overlapping and retardation of broods often ob-





Development stages of the Douglas-fir beetle are shown magnified under bark.

scure the demarcations between generations. Usually, the species winters in the adult stage, but larvae are also found during the winter months. Wintering adults emerge early in the spring, while delayed broods come forth later in the summer. Most adults die after completing two attacks on trees. In the Pacific Northwest, the Douglas-fir beetle is most apt to attack weak or fallen trees. But in the Rocky Mountain area, the beetles also infest uninjured timber.

Scolytus unispinosus Lec. is a primary enemy of young Douglas fir. Somewhat smaller than the Douglas-fir beetle, it is only about one-eighth of an inch long, and has a distinctive, visible spine. Egg galleries are shorter, too, ranging from one and a half to three inches, parallel with the grain.

This small beetle is polygamous, and each female makes a separate egg tunnel from a central chamber where a male waits to serve her and other females. There is a short entrance tunnel leading to the main gallery; the central "nuptial chamber" is constructed at the juncture. The larvae first mine straight out at more or less right angles to the egg gallery, and then up and down the tree in such a way that their mines do not cross each other. This species produces two generations annually. Adults of the first brood emerge along with the parent generation about April; the second brood comes forth about July. Females may establish more than one colony and infest more than one tree.

Among the other species, *Scolytus ventralis* Lec., which attacks the white firs in Washington and Douglas firs in Oregon and California, differs from the Douglas-fir engraver in that it has no prominent spine. Anothe common Douglas-fir bark beetle, *Pseudohylesinus nebulosus* (Lec.), prefer the barks of recently felled or injure Douglas firs. These small, grayish- an yellow-brown bark beetles are as smal as *S. unispinosus* and frequently wil kill trees of small diameter. Their worl is distinguished by the absence of an well-defined nuptial chamber in th inner surface of the bark. The gran fir bark beetle, known as *P. grandis* attacks trunks or limbs of weakene or dying Douglas firs, and runs true t familiar form. It is one-eighth of a inch long and shaped like an elongate oval, but it differs from other species i its covering of brown and gray scales

Since beetles have never been know to perform for laboratory observatio as they do in the woods, scientists hav made periodic observations of the by removing a small section of bar from infested trees. Also, screen cage attached to the trees collect emergin adults for close observation.

It is not possible to declare with absolute certainty which species create the attractive engravings that appea on these pages. It should be mentione that the work of most engraver beetle is nondescript and uninteresting a "art." Yet if noteworthy composition come through a large mill as seldo as five times a year, their rarity alon justifies a lumberman's watchfulnes

Larva mines a broader tunnel in orde to accommodate its increasing siz producing the "foliage" effect, *belo*

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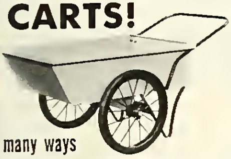

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About the Authors

Dr. George B. Schaller, author of "Mountain Gorilla Displays," is a Fellow at the Center for Advanced Study in the Behavioral Sciences, at Stanford University. His field work has included ecological and behavioral studies of birds and mammals in Alaska and elsewhere for the Fish and Wildlife Service and the National Park Service. From 1959 through 1960 Dr. Schaller was with the African Primate Expedition in the eastern Congo and western Uganda. The article was excerpted from his book. *The Mountain Gorilla*, recently published by the University of Chicago Press.

The description of the Hyksos that appears under the title "Rulers in the East" is the work of Dr. Emmanuel Anati, whose academic distinctions include four advanced degrees from the Sorbonne, Harvard University, and the Hebrew University in Jerusalem, and he has led a number of archeological expeditions. His article appeared first in his new book *Palestine Before the Hebrews*, published by Alfred A. Knopf.

Dr. Niko Tinbergen, who wrote "The Shell Menace," is a Reader in Animal Behavior at the University of Oxford. England. An eminent animal behaviorist, Dr. Tinbergen heads a research team—financed by England's Nature Conservancy—that is studying the ways animals are adapted to their natural environment. He is a Corresponding Member of The American Museum and was elected a Fellow of the Royal Society in 1962.

A Professor in the Department of Agricultural Microbiology at Rutgers University, in New Jersey, Dr. David Pramer has long been interested in alchemy, which he considers the forerunner of modern laboratory science. Dr. Pramer obtained the art reproductions that accompany his article through the co-operation of Messrs. H. M. Schwalb and S. Connolly, at The Fisher Collection.

The strange behavior of lemmings is discussed in "New Theory on a Fabled Exodus," by Dr. Kai Curry-Lindahl. He is with the Zoological Department of the Nordiska Museet and Skansen, in Stockholm. In addition to his mammal studies, Dr. Curry-Lindahl is also well known for his work with the wagtail.

In "Engravings Beneath the Bark," Miss Marjory M. Fisher discusses the delicate designs that the Douglas-fir beetle traces in wood. Miss Fisher, formerly a journalist, has written many articles in the field of nature.

Photographs of Lepidoptera in the June-July, 1963, issue were made with the co-operation of the Smithsonian Institution and Dr. J. F. Gates Clarke, Curator, Division of Insects. All of the specimens are in the national collection.

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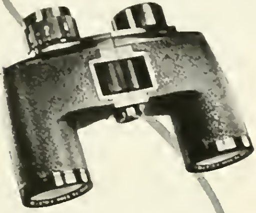

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NATURE IN
ROCK & MINERAL

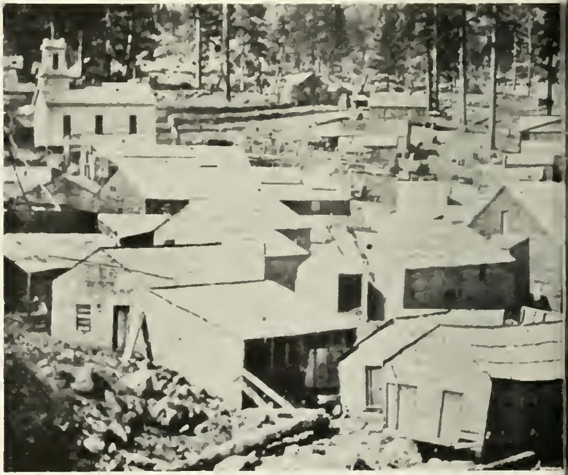
By Paul Mason Tilde

What is there about the heavy element gold that has throughout recorded history held such a tyrannical grip on the mind of that strange mammal, man? There are elements that are rarer; there are some that are heavier; there are many that possess odd physical characteristics that would seemingly make them more fascinating than gold. And yet the search for gold has been responsible for the exploration of much of the earth's surface. The metal itself has served as the foundation for much of the world's trade since time immemorial; it has been a reason for crimes of the most atrocious sort, and for human acts of great charity and philanthropy.

Since the beginning of human history man has amassed a total store of some 50,000 tons of gold—a hundred million pounds—most of which has been stained with blood. In modern times, some of o
economists have advocated the abando
ment of the element as a measure
value and as a currency reserve. Perha
their idea has some merit—this colum
has no pronouncement to make on th
score—but to date, it seems that the on
humans who show any tendency to aba
don gold to chemists and metallurgis
have been the economists themselves.

Era of Discovery

It was pointed out in a recent iss
(Natural History, November, 196
that the two most significant mineralog
cal events of the nineteenth century,
terms of the nation's growth and eco
omy, were the discovery of vast tonnag
of native copper and copper ores in t
Upper Peninsula of Michigan, and t
tapping of a great storehouse of go

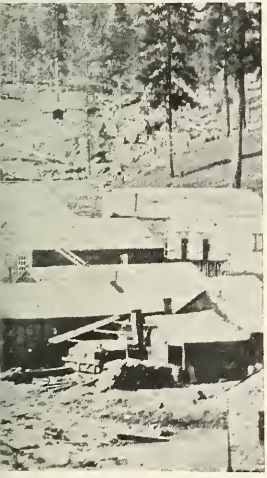


Nevada City, California, is shown in this 1852 photograph. A sudden creation of the Gold Rush, the town incorporated i
1851 under a special act of the legislatu

ong the western flanks of the Sierra evada in California. These two events llowed one another within a span of latively few years prior to the middle the century. The gold of the Sierra evada represented, for the most part, placer accumulation that had been colcting downslope from the Mother Lode nce the Tertiary period or earlier.

The placer accumulation weathered om the 120-mile-long Mother Lode, the rip of quartz veins emplaced along a eat fault zone at the western edge of e Sierra granite batholith. The comned gold production of both the placs and the veins that spawned them has een conservatively estimated at more an a billion and a half dollars.

Geologically speaking, the story of alifornia gold is best told in reverse quence, for it was the placer metal, deved over the ages from the slow disinteration of an unknown portion of the other Lode, which first inflamed the agination and cupidity of a relatively oung republic. The notion that gold isted in California in great quantity as not by any means new in the year 348. History is replete with references real and fancied treasures in the terin that now comprises our Golden tate. One of the earliest reports was enned by the Spanish soldier and writer arci Ordóñez de Montalvo, not long ter the discovery of the New World, nd was published in Toledo, Spain, bout the year 1510. "Know that on the ght hand of the Indies," romanced eñor Ordóñez, "there is an island called alifornia, very near to the terrestrial paradise, which was peopled by black women without any men among them .... Their arms were all of gold, and so were the caparisons of the wild beasts which they rode after having tamed them; for in all the island there is no other metal. . . ."



epealed in 1852. It has reincorporated two imes since, and it still produces lode gold.

Some seventy years later the Englishman Richard Hakluyt wrote about the expedition of Sir Francis Drake that touched on the shores of California in 1579. A bit less romantic, but just as optimistic, Hakluyt said that "there is no part of earth here to be taken up wherein there is not a reasonable quantitie of gold and siluer."

Legend Becomes Reality

OVER the years there were other hints—some of them surprisingly factual—of a storehouse of gold somewhere within the territory that is now California. For example, in 1814, a Russian who was jailed in the town of Monterey by the Spanish authorities was found to have raw gold in his pockets. The Spanish suspected that the Russian had but recently come from the Sacramento Valley, but their prisoner refused to divulge the source of the metal. In July, 1845, John Bidwell of Chico, California, went into the gold country of the Sierra Nevada on the advice of a Mexican miner "ostensibly for the purpose of giving directions to men sawing lumber. . . ." but with the real purpose of examining the region for gold. Bidwell may well have narrowly missed fame and treasure; he withdrew from the venture only because of "the intense heat and the probability of finding no water."

The opening of the great treasure hunt was drawing closer. Thomas Larkin, United States consul in California (before its complete conquest by the Americans), wrote in 1846 to the editor of *The Sun* in New York that "near the town of the Angels . . . is a large sandy plain at the foot of some mountains where a common laborer can pick up placer gold to the amount of ten dollars & upwards a day—onze pcs [sic] have been found—the whole process is to shake up the sand with water in a plate or flat basket—the gold is worth as it comes from the sand 12$ to 15$ in C—17$ in the U.S. per ozn. . . ." Yet, this account failed to stir its readers.

On August 27, 1847, James W. Marshall, millwright by trade and originally from New Jersey, signed an agreement with John A. Sutter, California landowner and businessman, to build and operate for Mr. Sutter a sawmill at "Culluma" (Coloma), on the south fork of the American River.

Work proceeded on the mill during the fall of that year, and by January of 1848 the structure was nearly completed. To assist the men in the work of steepening the grade of the mill's

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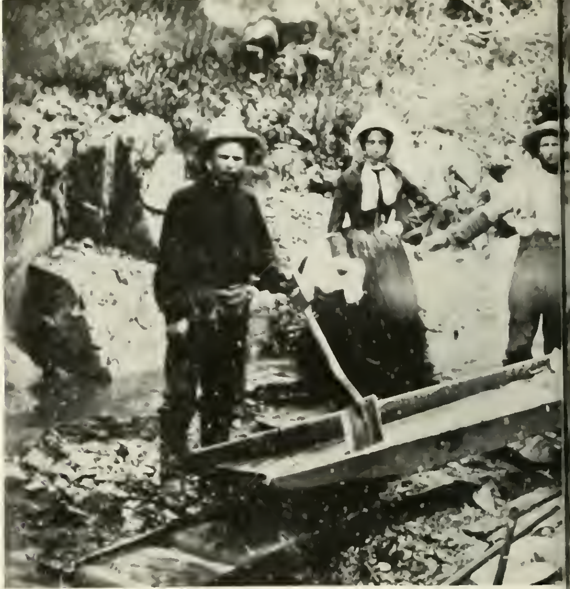
tailrace it was Marshall's habit to open the water gate at the head of the race after working hours. This permitted water from the South Fork to help in the excavation process during the night. Apparently Marshall was usually the first man to arrive at the mill for work in the morning, and—according to his later recollection—on a morning between January 18 and 20, 1848, he closed the water gate and inspected the tailrace "to see what had been done by the water through the night."

One Night's Bequest

What had been done "by the water through the night" was sufficient to change the tenor of a nation's economy from one of paper to one of gold, to create an American West Coast empire and an era in history that is best described by men like Bret Harte and Samuel Clemens.

The first piece of gold picked from the lower end of the tailrace at Sutter's Mill by Marshall weighed, in his words, "about forty cents." Let the diary of Henry W. Bigler, a Mormon employed by Marshall, tell of this fateful discovery. The entry in Bigler's diary does not agree as to date with Marshall's report, yet it may be that neither was exactly correct:



FAMILY of immigrant prospectors from the East here pauses for a brief rest next to their long tom in this nineteenth-centu photograph of a typical small operation

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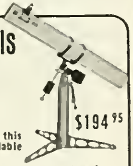

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uburn Ravine site in the heavily worked rea northeast of the city of Sacramento.

"Monday 24th this day some kind of mettle was found in the tail race that looks like goald first discovered by James Martial, the Boss of the Mill. Sunday 30th Clear and has been all the last week our metal has been tride and prooves to be goald it is thought to be rich we have pict up more than a hundred dollars woth last week."

Gradually the news of the discovery spread through California, then beyond. The "forty cent's worth" and the "hundred dollars woth" grew into a trickle of yellow metal, and the trickle grew into a torrent. By June of 1848, Thomas Larkin, still in San Francisco as a representative of the State Department, wrote to James Buchanan, then Secretary of State under President Polk, that there were more than two thousand people working for placer gold in the headwater streams of the Sacramento River—the American, Yuba, Feather, and other tributaries—and that countless others were moving toward the district. The coastal towns were being emptied of able-bodied folk at an alarming rate. Larkin told Secretary Buchanan: "This town [San Francisco] has one-half of its tenements empty, locked up with the furniture. The owners—storekeepers, lawyers, mechanics and laborers . . . [have] all gone to Sacramento. . . ."

A United States Army vessel tied up in San Francisco Harbor lost all but six of its men to the general migration. One Sandwich Island (Hawaiian Island) ship at dock lost an entire crew. San Francisco Harbor soon became a veritable forest of naked masts, without hands to raise a sail. Newspapers closed for lack of printers. "The *Star* newspaper office," wrote Larkin sourly, "where the new laws of Governor Mason, for this country, is printing, has but one man left." Then Larkin asked, "How many more in the Atlantic States . . . will leave for this country under such prospects?" The answer to this query became a famous and romantic episode in American history—the storied rush of the Forty-Niners.

Machines to the Fore

THE simplest of the machines used to recover placer gold from the California diggings was the gold pan, still familiar to many mineral enthusiasts because of its present use in separating heavy minerals like garnet, monazite, or zircon from their associated sands.

A more sophisticated apparatus was the so-called long tom, used where there was a sufficient head of water for its operation. The long tom consisted of a wooden trough that varied from twelve

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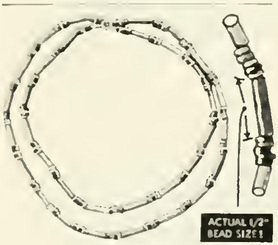
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to twenty feet in length, and was a foot or so wide. An enlargement at its lower end accommodated a perforated iron sheet; under the sheet was attached a shallow "ripple box" containing wooden cleats. A stream of water was fed into the upper end of the long tom, which was set at a slight inclination from the horizontal so that water would run down it as through a chute. Gold-bearing earth and gravel were shoveled in. One man stood at the lower end of the machine to throw out accumulations of rock and debris and to keep the earth and gravel in motion over the iron plate. As the lighter soil washed away with the muddy water, gravel, sand, and gold particles fell through the holes in the iron plate into the ripple box below, where minerals of high specific gravity were caught behind the wooden cleats. Once a day, or oftener if necessary, the minerals trapped by the cleats were removed and panned out in the ordinary manner.

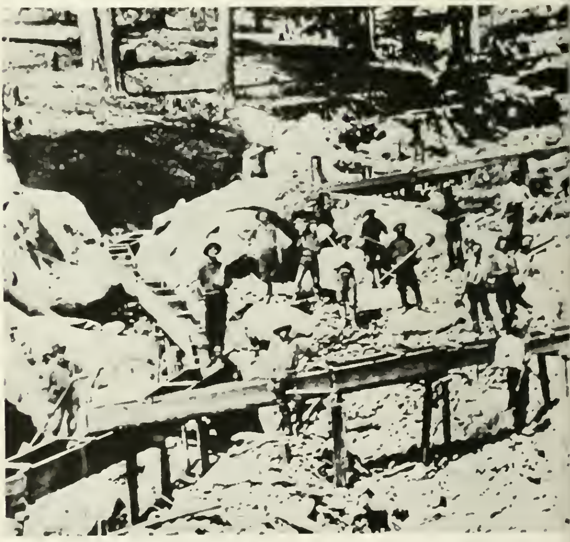
Where a continuous stream of water was not available, a "rocker," or "cradle," was used. This was essentially nothing but a box on rockers, with a sieve near its top and—like the long tom—a punched iron plate and cleated box at the bottom. Gravel was shoveled onto the sieve, and water splashed onto the gravel; the box was rocked back and forth to keep the flow of water and gravel in motion, and heavier minerals piled up behind the cleats after falling into the box below. A team of three men—a digger, a water carrier, and a rocker—might pan out a hundred buckets of gravel in a day with this method.

The "sluice," or "sluice box," was an elongated version of the long tom adapted to situations where water was abundant and available at a good head. A number of sluice boxes were often fastened together in a continuous line depending on the number of men available to keep the apparatus supplied with gravel. Some of the longest sluice boxes were operated for several days before being cleaned of their accumulated gold and other heavy minerals, which occasionally yielded a small diamond or a nugget of platinum. (The source of these diamonds has remained a mystery to the present day.)

Great Leveler

THE institution of the hydraulic method that washed away entire California hillsides of earth and gravel into arrays of sluice boxes—an operation that left still-visible scars on the landscape in the placer districts of the state—was credited to one E. E. Matteson (or Mattison), former citizen of Connecticut. The method dated from 1852 or 1853, when it was probably first introduced at the diggings called "Yankee Jims," in Placer County, California.

By this method, water was brought from waters above into the lower can-



SLUICING OPERATION that was established on the "Cayote Diggings" at Nevada City is shown in a photograph made in 1851. Activity of this size left lasting scars.

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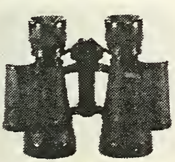

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yons by costly wooden flumes (quickly constructed aqueducts), and maintained at a considerable height above the gravel to be washed. At appropriate intervals the flumes were tapped by hoses. The head of water thus provided, when directed by a nozzled hose at a hillside, exerted enormous force; the hillside was usually undermined at its base and allowed to "cave" as the operation progressed. The caving process frequently claimed the lives of careless or adventuresome miners, but it produced gold in tremendous quantity. Eventually, it left the countryside as desolate as that of some of our Eastern states where coal is strip-mined.

Farther down on the principal gold-carrying rivers, where depths were favorable, dredging machines were used to drag gold-bearing gravels from river bottoms. The earliest such machines were apparently not well designed, and it was not until later years that the large-scale use of the gold dredge became widespread on the lower reaches of the rivers. Concerning one such early device, the traveler and lecturer J. Wesley Jones remarked: "this machine dredged more money from the pockets of the owners than . . . from the bed of the Yuba."

This, then, was a fabulous era in the history of American mineralogy. While producing some great fortunes, it peppered the foothills of the Sierra Nevada with names like Ragged Breeches Bar, Whiskey Slide, Hell Hollow, Red Dog, Shirt Tail Bend, and Jackass Hill. It held romance, heartbreak, disaster—and vast quantities of that irresistible yellow metal called gold.

The Mother Lode

PERHAPS there is some injustice, mineralogically speaking, in appending here a short account of the true Mother Lode, the geological wellspring of the Gold Rush romance. It is worthy of a longer discussion. However, lying to the east of the great placer deposits of California, in a band only a mile or so wide at most, is the almost continuous series of quartz veins and associated gold-bearing "country-rock" of the Mother Lode. In several places, huge, wall-like masses of white quartz stand in relief over the weaker rocks of the belt, looming against the green of a rolling and thinly forested countryside. These were the quartz outcroppings of the true Mother Lode that caused J. D. Borthwick, a transplanted New Yorker and writer-artist (who had also tried his hand at the gold diggings), to report in 1857 that "a great quartz vein . . . traverses the whole State of California."

The first gold-bearing quartz vein in this elongated system was discovered on Colonel Frémont's Mariposa Grant near the southern terminus of the Mother Lode, probably in August, 1849. Most of

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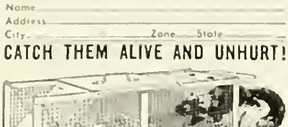

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the production from the hard-rock mines of the Mother Lode came, however, from the northerly end of the Lode, between the towns of Plymouth and Jackson, in Amador County. Countless shafts have been sunk into the great quartz vein from one end to the other since the Mariposa Grant discovery—for the most part, the undertakings of one, two, or a small group of hopeful miners. But the major production of gold has always been limited to few more than a score of steady operations.

In the earlier days of hard-rock mining on the Mother Lode there were some spectacular producers, some of them long-lived. The Keystone Mine in Amador County, for example, began gold production in the middle of the nineteenth century; in 1855, it was recorded that the mine paid its stockholders $550 per share per month in dividends. There were other rich producers, too, but they were the exception rather than the commonplace. All told, the white quartz of the Mother Lode has yielded perhaps a quarter of a billion dollars in gold.

The mineral suite of the Mother Lode veins is not a large one, although aside from gold, it includes several minerals of more than ordinary interest to the collector. Outstanding among them is the beautiful, green, mica-like mineral called mariposite, the color of which is perhaps related to its minute content o the element chromium. It is found extensively along the southern portion of th Mother Lode. Another particularly interesting mineral is petzite, a telluride o gold and silver found in some of th mines at the northern end of the belt One or two Mother Lode mines have furnished specimens of such mineralogica goodies as coloradoite, the telluride o mercury; calaverite, the ditelluride o gold, which takes its name from a county of the Mother Lode district; and altaite the telluride of lead. Commoner minerals include galena, arsenopyrite, sphalerite, and tetrahedrite. The latter is a complex sulphide of copper, iron, zinc silver, antimony, and arsenic. A specimen of any of these interesting minerals from the Mother Lode country is certain to remind its owner of the wealth and romance of the golden days gone by.

This list details the photographer, artist, or other source of illustrations, by page.

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4 Joseph Sedacca
10-17 George B Schaller
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36 Hubert C Birnbaum
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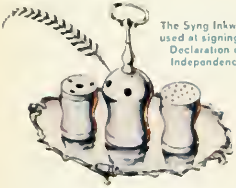

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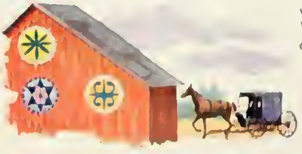
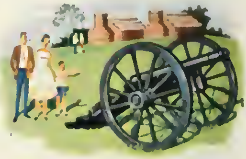


Decorative "hex" signs in Pennsylvania Dutch country



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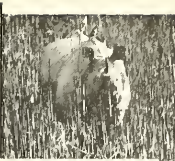
A bird opening a milk bottle? (See page 299)

The animal world's most discriminating eater? (See page 187)

The "best dressed" in the animal kingdom? (See page 226)



The world's largest mobile cafeteria? (See page 15)

A 10-foot, 300-pound dragon? (See page 259)

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THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

Vol. LXXII OCTOBER 1963 No. 8

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COVER: Daylight filtering through snow and ice illuminates a snow tunnel at the South Pole with an eerie, blue glow. Silhouetted against an electric light at one end of the passage is a scientist who periodically checks seismographic equipment installed in chambers to which the tunnel gives access. As research in the Antarctic progresses, numerous scientific methods wrest from layers of snow and ice clues to the earth's history in the remote past. For a discussion of how and why these clues are sought, turn to William J. Cromie's article, "Secrets from Cold Storage," starting on page 20. Cover photo by David Linton.

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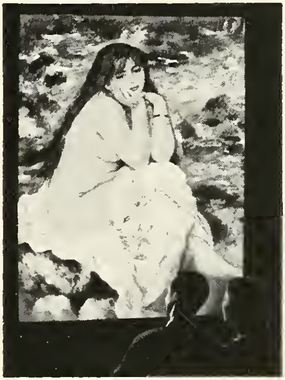

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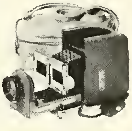

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Reviews

Oceans, mountains, islands
maps, men, and histor

By Bruce C. Heeze

STANDARD ENCYCLOPEDIA OF THE WORLD'S MOUNTAINS and STANDARD ENCYCLOPEDIA OF THE WORLD'S OCEANS AND ISLANDS, both edited by Anthony Huxley. *G.P. Putnam & Sons, $10.95 each; 383 pp. each, illus.* SEAS, MAPS, AND MEN, edited by G. E. R. Deacon. *Doubleday & Co., $9.95; 297 pp., illus.*

THESE three handsome volumes were produced in the United Kingdom and printed in Europe. Each is profusely illustrated with both color and black-and-white photographs, and in the case of *Seas, Maps, and Men* with reproductions of ancient prints, colored maps, profiles, and nautical charts.

Each of the two volumes of the *Standard Encyclopedia* edited by Huxley contains over three hundred well-written, absorbing articles on mountains, islands, and seas. The *Standard Encyclopedia of the World's Mountains* is introduced by an essay dealing with mountain formation, the history of mountaineering, and mountaineers. In the body of the encyclopedia, historical, cultural, and mountaineering aspects of the subject are treated in a popular style. Emphasis is placed on who scaled the mountains first and on the historical importance of mountain barriers or passes in terms of political history. Physical characteristics are not ignored and the geology of the mountains is frequently discussed, particularly in connection with the volcanic peaks. The selection of the mountains treated in the encyclopedia is reasonably representative of the highest peaks of the world, but the selection of lower peaks is biased toward Europe and North America. Only two mountains are included from Antarctica. A gazetteer containing brief statements on mountains not considered important enough to deserve a full article is contained in a twenty-nine page glossary. Although in several instances incorrect elevations are given (Everest, McKinley), other statements seem to be reasonably accurate.

The *Standard Encyclopedia of the World's Oceans and Islands*, also edited by Huxley, includes material by thirty-one contributors, is laid out in a similar form, and deals with various islands, seas, banks, straits, and peninsulas. Although
largely directed toward cultural an
historical aspects of the areas, it als
carries a few articles on their physic
structures, as those of the Gulf Strea
and Gulf Stream countercurrent, th
Tonga-Kermadec Trench, the Mid-A
lantic Ridge, and a few other feature
The book is well written and can
either read for pleasure or used as
reference work.

The maps in the two books are rath
perfunctory, and simply show the ge
eral location with respect to a genera
ized shoreline of the various featur
described in the encyclopedia. As ind
maps they are barely passable. Each
the maps is overprinted with an identic
rectangular locator grid, placed witho
regard to projection, latitude, or long
tude, and one map on a polar projecti
has a rectangular grid. In fact, the ma
have no geographical co-ordinates
scale and show no details except f
some generalized relief in the case of th
mountains and some generalized bath
metry in the case of the oceans. It
therefore absolutely imperative to ha
at hand a good atlas when one rea
these books. The inclusion of detail
maps, however desirable, would ha
greatly increased the expense and size
the volumes, and perhaps the editors ca
be given credit for good judgment in n
attempting to make these into atlases.

It is also regrettable that the popul
production style did not allow the i
clusion of any bibliographic materia
No sources are cited and no hints a
given as to where one might further pu
sue a given subject. *Oceans and Islan*
might at least have contained a referen
to the Coast Pilots and Sailing Dire
tions published by the various hydr
graphic offices of the world. In rega
to *The World's Mountains*, a handy re
erence is also lacking and it would ha
been indeed a contribution if the edito
had included hints on source materi
where one could dig deeper. The col
reproductions are generally poor.

Seas, Maps, and Men is a large, han
some volume that deals with the histo
of sea exploration. Originally publishe
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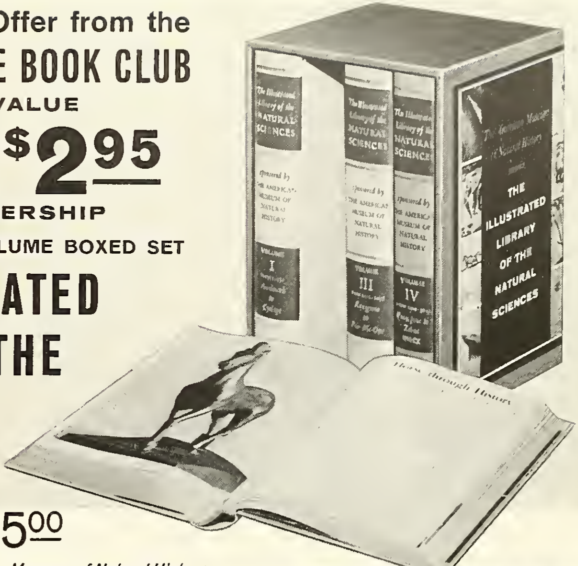
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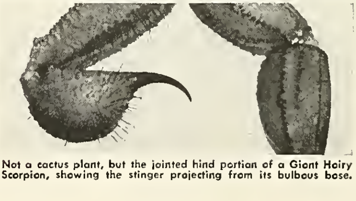

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It is profusely illustrated in both black and white and color. The first too brief, but interesting chapter by geophysicist T. F. Gaskell reviews theories of ocean basin formation. Edward Shackleton spends about twenty-five per cent of the book describing the expeditions and lives of six famous geographical explorers (Pytheas, Magellan, Cook, Ross, Nansen, and the crew of the *Nautilus*).

The third chapter, "Life in the Sea," is by biologist Maurice Burton and comprises another twenty-five per cent of the book. It is an admirably written popular summary of plankton, fishes, and the history of marine biology from the nineteenth century to the present.

Another quarter of the book is by N. C. Flemming and is concerned with the exploration of sunken wrecks, submerged cities, and other concerns of submarine archeology. I found it the most interesting and perhaps best-written chapter.

The final chapter, "New Attack on the Sea," treats various aspects of oceanography. The first section by G. E. R. Deacon traces the development of physical oceanography from the mid-nineteenth century to the present. "The Floor of the Sea," by Dr. A. S. Laughton is a fine summary of geological oceanography. Dr. J. C. Swallow, a man who has done some of the most important work on deep-sea currents, contributes a short section on ocean currents, and Professor K. F. Bowden gives some brief remarks on the tides. Dr. C. A. M. King presents an interesting review of "The Edge of the Sea," and Ronald I. Currie discusses practical and commercial uses of oceanography, including tidal power projects.

The book is concluded with an appendix of "Facts About the Sea," which includes much useful information, maps, and diagrams. For some inexplicable reason, an appended list of oceanographic expeditions ends with an expedition that was made in 1933.

In contrast to the two volumes of the *Standard Encyclopedia* discussed above, this book makes for a spectacular but largely unsuccessful attempt at providing adequate illustrative maps. It contains twenty-four specially constructed "shadow-relief maps" that purport to show the ocean floor in relief. One identical base map of the world is produced eight times with a variety of dazzling colors overprinted to depict bottom deposits, productivity zones, routes of major expeditions, and so on. On most of the maps the lettering is too small to read. But a more serious objection is that in only one or two notable instances did the preparators take the trouble to obtain reliable contours. The excellent map of the Bay of Biscay shown on page 197 is a notable exception. The poorly executed contours and the dazzling colors obscure the distribution that the maps are intended to illustrate. The technique, however, is basically a good one, and i better contours were obtained and perhaps more subtle coloring were used, th result could be excellent, as is clearl shown by a few of the maps. Despit these latter inadequacies, I can recommend the book highly to the non-specialist. I think these three popular attempt are well above the level of normal popularization. In each case, experts in th area have been consulted not sufficiently, in the case of the maps, but stil some attempt was made. The chapters i *Seas, Maps, and Men* bear the authorship of respected authorities, and th encyclopedia volumes have been carefully compiled and care taken to insur accuracy, if not completeness. None o the books makes any pretense at exhaustive treatment. The encyclopedias, o course, attempt to include some remark on all the more important features o their subject matter; however no attemp is made to treat each in a systemati manner, which would have led to a drier less entertaining style. The producer and authors of these books are to be commended for producing very satisfactor popular works that will be useful an entertaining for some years to come.

An Assistant Professor of Geology a Columbia University and a staff membe of Lamont Geological Observatory, Dr Heezen specializes in deep-sea geology

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THE STATE PARKS, by Freeman Tilder *Alfred A. Knopf, $5.50; 496 pp., illu*

THE National Park Service, with support from Jackson Hole Preserve Inc., and Resources for the Future, Inc commissioned Freeman Tilden to writ an up-to-date, authoritative account o the state parks, which could serve as " guide in state planning and development, in the establishment of appropriate policies and practices, and in th winning of public support." No appraisal of future needs or dangers wa included in this commission as outline in a foreword by Conrad L. Wirth Director of the National Park Service

The book has three major section The first is a review of the developmen of policy and, to a lesser extent, of th growth of the state park systems sinc the states joined with the National Par Service in 1921 to create the quasi official National Conference on Stat Parks. This section, by far the most vita and pertinent, is contained in 42 page while the bulk of the volume is devote to short accounts of 74 state parks beaches, and monuments in 41 states an "thumbnail sketches" of 111 other properties. The third section, appendixes and B, consists of a brief description o the still-embryonic park programs i Alaska, Arizona, Colorado, Delaware

Hawaii, Kansas, Utah, and Wyoming and a statistical summary of the number of areas and total acreage administered as state parks and related properties by each of the fifty states.

The purposes of state parks are reduced to three: preservation of natural landscapes, access to water areas or wooded recreation tracts, and preservation of historic sites. The parks are considered to be intended primarily for the people of the state, but are available also to visitors from other states without bias. (This last consideration, by the way, is a subject of deep concern to many park administrators. Certain parks, located near urban centers of another state, are used overwhelmingly by out-of-state visitors.)

The hodgepodge of administration from state to state is introduced, but not in a comprehensive presentation. Administrative problems, too, are slighted, except for mention of the need for a merit system of appointments, rather than the political game of musical chairs characteristic of most park systems, so that more career personnel can be attracted into park administration and management. This section could have been expanded to emphasize this worthy argument and to reveal the appallingly low salary scales of many park systems.

The sketches of the various state properties, including such famous areas as Adirondack Forest Preserve, N.Y.; Franconia Notch State Park, N.H.; Valley Forge State Park, Pa.; Highlands Hammock State Park, Fla.; Indiana Dunes State Park; Itasca State Park, Minn.; and Humboldt Redwoods State Park, Calif., will give the armchair traveler several hours of absorbing reading, for Mr. Tilden has a tremendous ability to convey his enthusiasm for such interesting areas to his readers. It is regrettable that the author did not mention the outstanding series of publications issued by various states explaining the geology of their parks and permitting the visitor to identify the plants and animals commonly seen on the properties.

A further disappointment is the omission of the case histories of the flagrant abuse of parks in several states. For example, the author might have mentioned the desecration of Little Mountain, Oak Mountain, Valley Creek, and Bladon Springs State Parks in Alabama by lumbering; he might have discussed the peculiar policies that allowed New Jersey to sell a small state park outright (a move later rescinded), or that allowed another park to be invaded by a utility right of way without a public hearing. Still another case was the state that refused to permit a scientific study of vegetation-management practices to be made on abandoned farmland within a park because the study might have interfered with natural processes, but subsequently

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leveled a similar area to permit the installation of an air-strip for private planes. There is also only passing reference to the recurring and almost irresistible threat to park lands by superhighways, utility lines and pipes, microwave tower installations, and similar cross-country systems. Park lands, already in public ownership and lacking costly developments, afford cheap rights of way, and avoid costly condemnation proceedings and the ill will of displaced families and businesses. Too often, road design and construction on lands near a park are in such an advanced stage when right of way through the park is requested that administrators are forced into a position in which refusal is virtually impossible. And the program may develop so rapidly that the citizens who would decry and perhaps block such encroachment learn about it only after the trees have been felled and the graders are at work. Such was the case with Ohio's George Rogers Clark State Park.

Freeman Tilden has written an excellent guide to several of our outstanding state parks. Had his book been intended as a companion volume for his books on national parks and monuments, I could endorse it without reservation. However, the subtitle "Their Meaning in American Life," and Mr. Wirth's description of the penetrating analysis that was intended, make such an endorsement impossible. As a travelogue, it will be a valuable and pleasurable addition to one's library. As an analysis of today's strategic position of state parks—between a mediocre past and a challenging future—the book leaves much to be desired.

JACK MCCORMICK

ANIMAL SPECIES AND EVOLUTION, by Ernst Mayr. *Harvard University Press, $11.95; 797 pp.*

ERNST MAYR came to the American Museum in 1931 to study the huge collections of birds sent in by the Whitney South Sea Expedition. To say that he made the most of his opportunities would be an understatement. One outstanding result of his labors was the volume *Systematics and the Origin of Species*, which became a classic in the field of modern evolutionary studies.

Twenty years passed, Curator Mayr became Professor Mayr, and we have before us what began as a revision of the earlier book but became greatly expanded, more comprehensive, and essentially a new work. Genetical aspects of species are treated in much greater detail, but always against a background of how species evolved in the past and how they are interacting and changing in the present. Although crammed with facts and usually with two or three references to the scientific literature on every page, the careful organization and numerous subheadings of this reference work keep it from being confusing or overpowering.

Never a man to shrink from expressing an opinion, Mayr sometimes makes things seem more definite and positive than they are. This is useful in some quarters, but whether it is really in keeping with the tentative, statistical, and even groping, intellectual climate of our times is another question.

The species is one of the "fundamental particles" of biology—with some obvious characteristics, and with others that are more subtle. All biologists should read this book, and it may also be recommended to anyone who wishes to keep abreast of the main currents of scientific thought.

DEAN AMADON

THE EXPLORATION DIARIES OF H. M. STANLEY, edited by Richard Stanley and Alan Neame. *Vanguard Press, $6.00; 208 pp.*

THIS fascinating book consists of the hitherto unpublished, and only recently discovered, exploration diaries of Africa's most famous—perhaps infamous is better—explorer. There is little editing or editorial comment, but in the preface the editors provide an excellent background to the diaries. However, the publishers could have helped by being more generous with maps to help the reader follow Stanley's tortuous journey.

The diaries themselves concern Stanley's second African Expedition, rather than the first, which was designed to discover a somewhat reluctant Livingstone. This second time Stanley set out primarily to solve the riddles that had long been plaguing geographers; just where lay the sources of the Nile and of the Congo? Stanley had an additional personal interest; did the great north-flowing Lualaba River flow *into* the Congo or did it even turn westward and *become* the Congo?

One of the exciting things about these diaries is that they present a factual record of some of the most profound discoveries of our time. It is hard to realize that it was less than ninety years ago that Stanley mistook Lake Edward for Lake Albert and also charted the shores of Lake Tanganyika.

The editors point out that in these diaries Stanley is often too tired or too sick to posture, but every now and then the idea crossed his mind that only his diaries might survive. Then we get a full broadside of his familiar bombast. It is revealing to read both accounts. In his diaries Stanley is exposed as a ruthless, egocentric, but extraordinarily pertinacious, individual. He was also an incredible bore, and it is certainly not his writings that fascinate the reader, but the man himself and his general indifference to anything except the comple-

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A college dean who long since abandoned the academy for the wilderness, Olson's runes range freely from Indian legends and a marvelous description of the *sauna*, the Finnish steam bath, to wonderful yarns about ghost camps and jumping-off places.

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tion of his appointed task. If we compare the diaries with his best-selling book, *Through the Dark Continent*, we see another side of Stanley—a bland disregard for the truth when it suits him. In *Through the Dark Continent* Stanley continually offers "extracts" from his diaries, and a cursory cross-check shows the extracts to be contrived, distorted, gaudily elaborated, or totally invented.

Other aspects are no less unsavory. Shorn of the excuses that adorn his published works, Stanley's employment of the greatest slave trader in the whole of Africa leaves one somewhat aghast, particularly in relation to his periodic descriptions of the horrors of slavery. But this is nothing compared with the intolerance and inhumanity that creep unwittingly onto almost every page. Not only do the "savages" come under fire (although Stanley openly scorns them as a worthless, thievish lot), but his European companions are equally considered as mere expedition fodder: "The Europeans are well, but are of little use to me as they are frequently sick. . . ." None of Stanley's European companions was destined to survive.

At times Stanley's brash intolerance smacks of musical comedy: "Captured a man today who repaid us with lies." "Today I thought I would try to pass the day without fighting . . ." but he didn't. Equally amusing is his innocent surprise at not getting a friendly reception, although he had conscientiously attacked, destroyed, and pillaged wherever natives were "insolent," or would not give him the food and shelter he wanted—and had time and again demonstrated his friendship and support of Arab slave traders.

Less amusing is the man's immense and utterly callous brutality. One group of harassed Africans who refused to supply Stanley with food were personally greeted with a Winchester repeating rifle. "Six shots and four deaths were sufficient to quiet the mocking. . . . We captured three canoes, some fish and nets, etc., as spoil."

The best that one can say about Stanley, after reading these diaries, is what the editors say—that he was possessed of a "fervid will to conquer and achieve." His methods and motives as seen in his own words somewhat diminish that praise, and although nothing can reduce the importance of his discoveries, it is as well to point out that throughout that part of the Congo where Stanley hacked his way through the forest, he also hacked his way through the people—and the only people to remember him kindly are the descendants of the Arab slave traders. To the rest, even today, he is a savage, a bringer-of-war.

The why's and wherefore's of H. M. Stanley will probably never be known, but this publication of a portion of his diaries and logbooks reveals that the ad-

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venturer-explorer-journalist had an excellent sense of what the public will pay for, the tenacity to give it to them in the face of considerable odds (many of his own making), and a character perhaps more arrogant, inhuman, and intolerant than anyone else of his time

COLIN M. TURNBULL

THE VALLEY, by Lorus and Margery Milne. *Harper & Row, $4.50; 175 pp., illus.*

THIS is a slight book—slight in size, content, and significance. The Milnes describe the valley in which they have lived for a number of years. It takes some doing to find out just where this valley is, although the authors confess to living somewhere in northern New England, and the maps that enclose the book indicate a location on some tidal estuary. In writing a book of this sort, which purports to describe the fauna and flora and general ecology of a specific area, much is lost by not naming the place.

The Milnes start with the sun as the origin of all energy, and describe how this energy is applied to their particular locality. The description is larded with biological and historical facts to give it a bit of weight, but at least a few of these are likely to be contested. For example, was it the hunter who eliminated the cougar, as the Milnes state, or was it the general advance of civilization?

This suggests the impact of man on the natural world, and the Milnes do not get around to this subject until the end of their book, although they should have tackled it at the beginning.

Then there is this, about the impact of man and his cutting of timber:

"These changes in the woodlands help make us safe from bears and other wild animals while wandering in darkness in our valley. No bear or cougar or timber wolf is likely to surprise us."

This is not just precious writing. It's downright silly.

PIETER FOSBURGH

NATURE ADRIFT, by James Fraser. *Dufour Editions, $8.95, 178 pp., illus.*

THERE has been a great interest in the sea and its inhabitants in recent years, but many of the books dealing with this realm have appeared to be merely opportunistic. It is refreshing to find that *Nature Adrift* evokes a positive rather than a negative comment.

Fraser's unpretentious treatment of marine plankton—the small, weakly swimming animals and non-swimming plants—is entertaining and accurate writing, coupled with a good number of illustrations. It is by no means a "picture book," for the text carries itself admirably, but the excellent black-and-white photographs and line drawings have been chosen with care. Unfortunately, a few of the color photographs have not been reproduced well.

By his own admission, Fraser has not tried to compile an identification handbook, but has attempted to present a general account of the organisms that comprise plankton, jellyfish, protozoans, diatoms, and the myriad larval forms.

The book's basic foundation is laid in the first two chapters: a historical account and resumé of the materials and methods utilized in the study of these organisms. There follows a synopsis of the various taxonomic groups encountered in planktonic studies and a consideration of the interrelationships among the members of the community. The author concludes with chapters on the behavior of planktonic plants and animals and an evaluation of the sea as a possible source for agricultural expansion. The index appears to be useful, but the absence of even a short list of reference works for an interested reader is unfortunate. All in all—and in spite of the somewhat high price—this can be recommended as a fine sourcebook for the many questions that might arise in the mind of the curious non-scientist.

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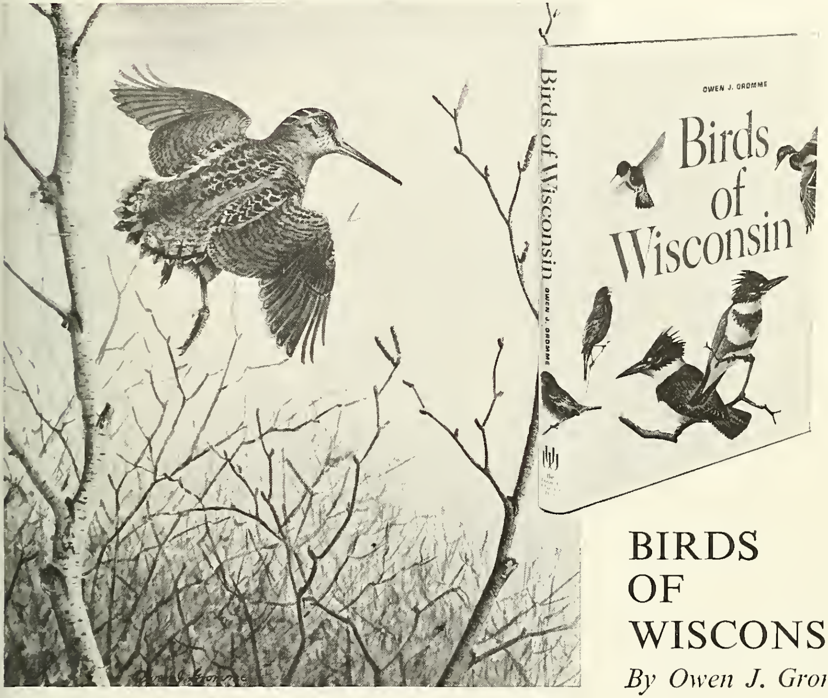

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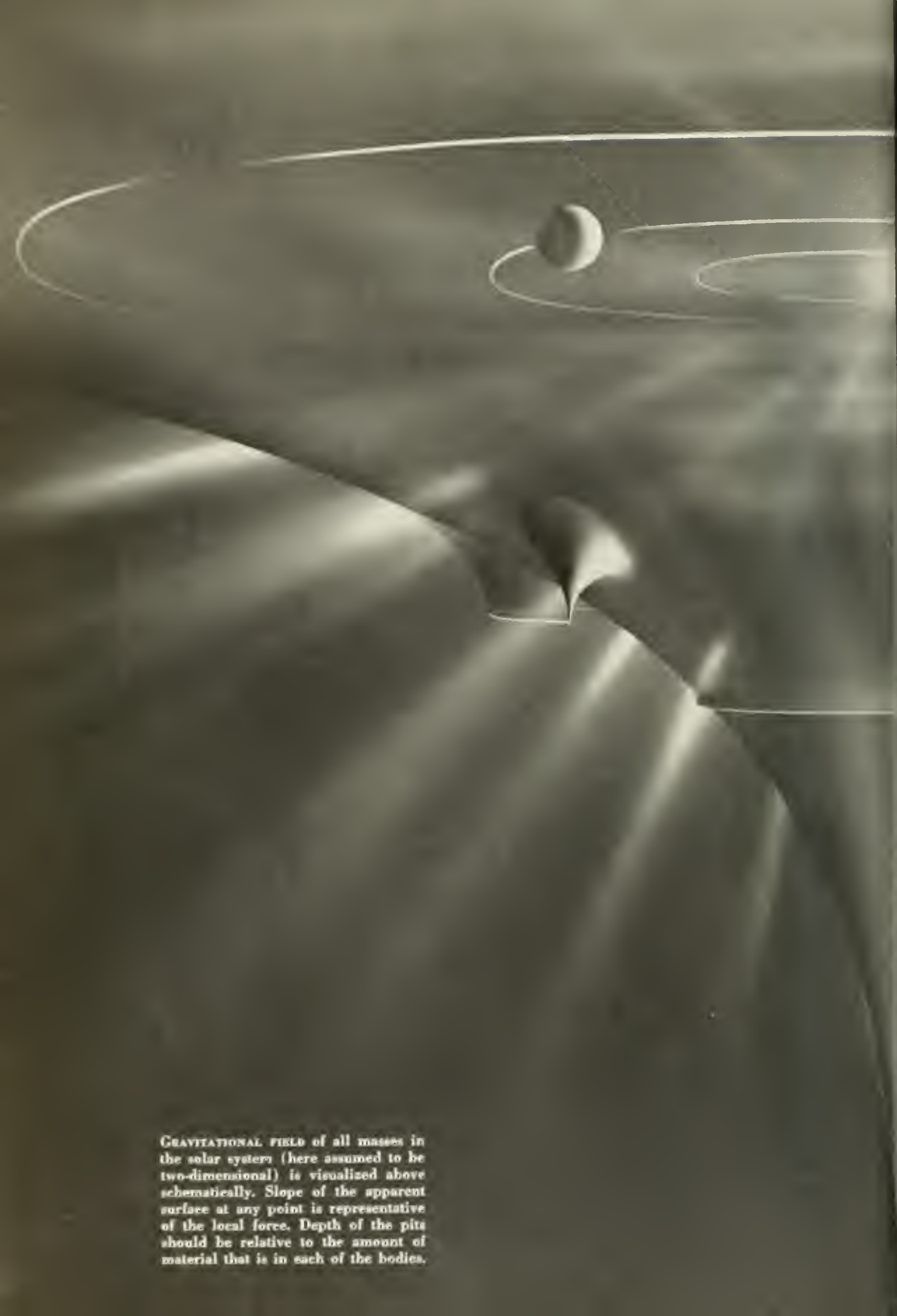


GRAVITATIONAL FIELD of all masses in the solar system (here assumed to be two-dimensional) is visualized above schematically. Slope of the apparent surface at any point is representative of the local force. Depth of the pits should be relative to the amount of material that is in each of the bodies.

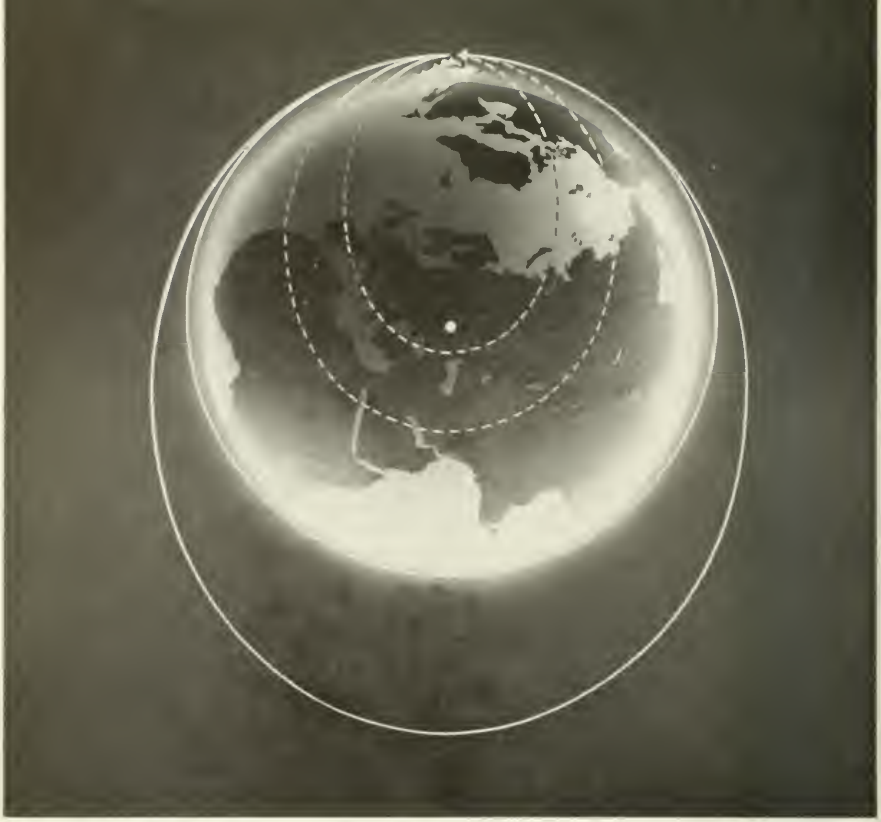
Gravitational Forces and Effects

Basic concepts are often misunderstood

By Kenneth L. Franklin

Drawings by Helmut Wimmer

Shortly after the Soviet Union launched the first earth satellite, Sputnik I, in October of 1957, the United States fired a rocket 4,000 miles into space in Operation Farside. The flight was successful and the rocket immediately returned to fall into the Pacific Ocean. During the next few weeks, astronomers at The American Museum-Hayden Planetarium in New York City were kept busy answering questions such as: "Theirs went up only 150 miles; ours went up 4,000 miles; why didn't ours stick the way theirs did?" A quick answer is not satisfying, but most callers were re-



AN OBJECT projected from a mountain (top of globe) with insufficient velocity does not "fall." Actually, it is in orbit about earth's center, but is interrupted by earth's surface. Higher projection velocity could produce completed orbit.

assured when told that these bodies were simply reacting the way they must in accordance with Newton's laws and that ours wasn't planned to orbit the earth. A fuller explanation is not too difficult, but it takes more time than a phone call allows and more space than newspapers usually want to use. Since the same and related questions are still being asked, this article will attempt to tell the story of gravitation and motion.

Our understanding actually begins over 360 years ago. The very careful Danish observer Tycho Brahe died in 1601 and left to Johannes Kepler, his mathematical assistant, years of the most accurate available information on the positions of the planets. Kepler studied this array of data and in the next twenty years published his three great laws describing the motion of the bodies in the solar system. His first law stated that all planets move in elliptical paths around the sun and that the sun is at one focus of the ellipse. His second law stated that the line connecting the planet with the sun would sweep over equal areas in equal times. Kepler's third law stated that the square of the ratio of the periods of revolution of any two planets was equal to the cube of the ratio of their mean distances to the sun. Kepler derived these laws and solved other problems of the planets' motion purely from observations. Isaac Newton explained why they worked in his *Principia*, published in 1687.

Newton's work was based on Kepler's laws and on many of Galileo's results obtained a generation earlier. From this foundation, Newton derived the famous law of gravitation. Using his newly discovered calculus, he was able to derive and improve Kepler's laws from this one great principle. The whole field of celestial mechanics has sprung from Newton's discoveries.

As Newton found, there is a force acting between any two pieces of matter in the universe. The magnitude of that force depends on the amount of matter in each piece, but not simply on the total amount of material. The force is proportional to the mass in one body *times* the mass in the other. This force is present no matter how far apart the two bodies are, but it is much stronger if they are closer together. Since the magnitude of the force increases in some way as the stance decreases, there is an *inverse* oportion acting. It turns out that if e initial separation is cut to one-ıarter, the force increases to sixteen nes its initial value.

Putting this all together, Newton ated that there is a force acting be- een any two bodies that is directly oportional to the product of their asses and inversely proportional to e square of their separation.

$$F = -G \frac{m_1 \times m_2}{d^2}$$

ırthermore, this force is one of traction between the two bodies, ence the negative sign. (This sign nvention is required when dealing ith directed quantities such as forces ıd velocities. A positive force is one repulsion and is encountered among e causes of comet tails. The numeral value of the force is independent the algebraic sign.) Newton did ot discuss what this force is, beyond ıming it gravitation, nor did he exain why it is always associated with ass. He only described how it ıanges with the amount of mass and ith the separation of the massive odies. There are no limits on the nount of material nor on the distance rough which this force may act. hus, any statement that a space probe as "escaped the gravitational pull of e earth" is based on ignorance.

ALTHOUGH some of its consequences are hard to understand at first, eryone has experienced this attracve force. If a man sits in a chair that as springs, the springs will be comressed by his weight until their reaction exactly compensates for his weight. That weight could be calculated by knowing the physical properties of the springs and by measuring their deformation. This is the principle used in most bathroom scales. One often hears of someone going on a diet to lose weight. This is not an exactly accurate statement. A drastic weight reduction may be made by being transported to the moon. There, a man weighing 180 pounds on the earth would weigh a mere 30 pounds! But, alas, his clothes are as voluminous as before. He has certainly lost weight, but not mass. Mass is the quantity of material in a body, but the weight of the body is the gravitational attraction another mass exerts on that body. Much confusion between meanings of the terms weight and mass is caused by the similarity in the names of the units of each. We say the man weighs 180 pounds; we mean his mass is such as to cause the earth to attract him with a force equal to 180 pounds-weight. It is his mass that is 180 pounds. Thus, his weight on the moon would be 30 pounds-weight; but his mass on the moon is still 180 pounds (as originally defined on earth).

One way of distinguishing between weight and mass on some other planet is to use a spring balance and a beam balance as pictured below. A spring balance will indicate the planet's force of attraction for a test body. The beam balance, however, compares mass with mass. On one side of the fulcrum is placed the test body; on the other side is placed the number of calibrated masses necessary to balance the beam. Since the attraction of the planet is the same for both the test body and the comparison mass, the masses on either side are equal. A comparison now between the reading of the spring balance and the amount of the comparison mass will give the gravitational force at the surface of that planet.

IN order to determine either mass or weight by simple methods, it is necessary to resist the force of attraction between the two interacting bodies. This restriction is provided by the chair the man is seated in or by the hook on a spring balance. A body that has lost its support is falling; it is no longer constrained, but is freely reacting to the earth's gravitational attraction. It has been at rest, but it now begins to move. It may be said that some force caused the body to change its position.

It is important to have a clear understanding of what is meant by "force," so that the term will not be used loosely. The idea is put forth by Newton in his three laws of mechanics.

His first law states that a body at rest will remain at rest unless a force causes it to move; if the body is already in motion, it will continue to move along a straight line at a constant speed, unless a force causes the body to change its direction, its speed, or both. This law is used to define the concept of force—that which changes a body's condition of rest or motion. Such a change is called an acceleration; thus a force produces an acceleration. If the condition of rest or motion of a body does not change, either there is no force acting or all the forces acting are balanced so they cancel each other's effects. The man in the

0
8
16
24
32
40
50

SPRING BALANCE, at left, measures a planet's force of attraction for a test body. Beam balance, at right, makes comparisons between masses.

chair is not falling, because the attractive gravitational force of the earth is canceled by the upward force of the springs. If he were standing on the ground, its compressibility, or resistance to deformation, is the springlike force that balances the gravitational force that is acting on him.

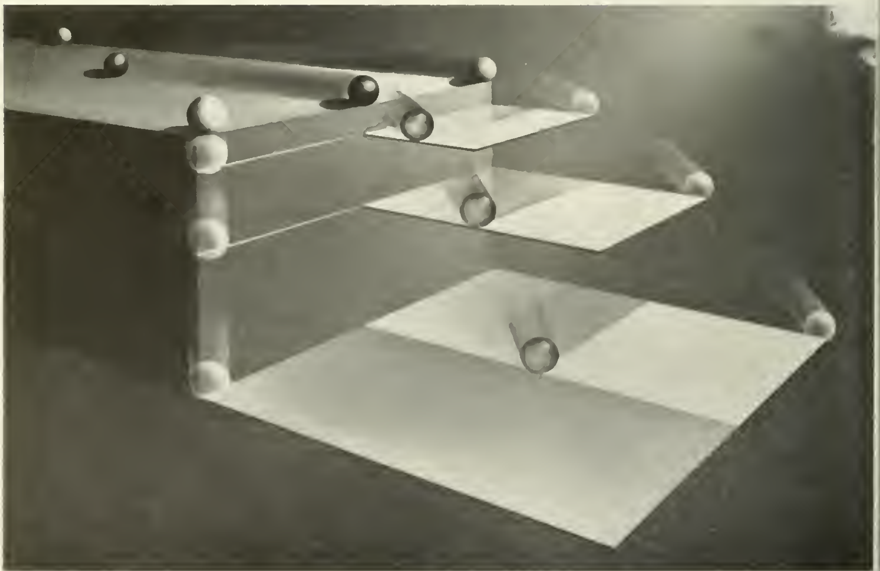
An acceleration involves time. A body at rest remains in a position that does not change with time. A body in uniform motion changes its position at a constant rate, expressed, say, in miles of change every hour. Time obviously enters the idea of velocity. Now, if the velocity changes uniformly, one could describe this as a change of a number of velocity units each second. But since the velocity units may be miles every hour, acceleration will be described as a change of so many miles every hour each second. This unit is a little awkward, so one often hears of feet per second per second as a unit of acceleration.

Years before Newton, Galileo Galilei had experimented in Italy with falling bodies. He found, in effect, that a pound of lead and a pound of wood fall at the same rate. Further, he found that one pound of lead falls at the same rate as ten pounds of lead. In other words, bodies fell the same distance in the same length of time, no matter how much they weighed or of what material they were made. (In today's more accurate world, this statement is absolutely true only when we neglect air resistance and other such problems unrelated to gravitation.) One might explain this to himself by saying, "Each pound does its own falling." This sounds right when it is first heard; on second thought, it sounds like a tricky use of words. But third thoughts reveal this statement to have meaning. Indeed, each particle of mass does do its own falling, because each is independently attracted to the earth whether or not it is fastened to its neighbors. When a stack of dishes being carried to the cupboard suddenly loses its support, each and every dish starts its journey to the floor simultaneously and each gathers speed together with its fellow. Each dish is doing its own falling, independent of the other dishes.

In the phrase "gathering speed" one may recognize the change of motion idea. In fact, most people think of acceleration in terms of gathering speed only, not realizing that changing direction is also acceleration. A term of fairly common knowledge is "acceleration of gravity." The numbers involved are rather interesting.

If air resistance is not considered, one finds that a body that started from rest has fallen 16.1 feet at the end of one second, 64.4 feet after two seconds, 144.9 feet after three, 1,610 feet after ten seconds. At this point, the body is falling at a speed of 322 feet per second toward the center of the earth. Air resistance is a complication, but in its simplest terms it represents a force acting in a direction exactly opposite to the body's motion. The effect of a force acting in such a way is to change only the speed of the body. The direction is unchanged. If some force could operate at right angles to the direction of motion, it would change only the direction of motion; the speed of fall would not be affected.

This last point can easily be demonstrated. Two identical balls are used. One is projected from a table top in a horizontal direction with a certain speed. The second is arranged to



FALLING is not affected by horizontal motion. All the balls strike the floor simultaneously, although the third, which is projected with twice the velocity of the second, hits twice as far from table as does the first, and unprojected, ball.

lrop from the table top just as the irst one leaves the table. They both xperience loss of support at the same nstant. They both begin to drop at he same instant, and they both arrive t the floor at the same instant. The econd ball strikes below the table dge; the first lands several feet away. f a third ball were projected with wice the horizontal velocity, it would trike twice as far away, but simulaneously with the strike of the first nd second balls.

These results were well known to ewton and he extended them in an ineresting way. Recall that the second all is being drawn along a line toward he center of the earth. What is the ath of the first ball? Locally, it looks ke a parabola. If the experiment were nade on a grand scale, say from the op of a mountain, the path of the first all would be seen to be an ellipse. The resence of the surface of the earth nterrupts the motion, however, and ne says the ball has fallen to the ound. As the ball is given an ever creasing horizontal velocity in each xperiment, it falls to the ground ever arther away. There is a horizontal elocity that is sufficiently great so at the falling body curves around h, just misses it at the other , and continues its motion. It can seen to rise from the surface of e earth from that point until it is s high as the mountain from which was projected. It has finally achieved closed orbit without the earth's surce interfering. In fact, the falling ody has always been in some ellipcal orbit that has the center of the arth at one focus, as described in epler's first law. If the ground had ot stopped the fall, the orbital properes would have been obvious. If the orizontal velocity from the mountainp were increased even more, the fallg body would rise from the surface to e much higher than the mountain at e opposite side of the earth.

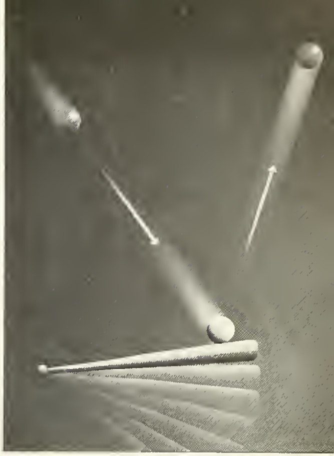
NOWHERE in the preceding two paragraphs was any sharp disinction made between a falling body nd a body in orbit. In the experiment, ne of the balls fell straight down; the ther had a constant horizontal comonent of motion in addition to its alling motion, but it still fell. Actually here is no physical distinction beween falling and orbiting. In either ase, the bodies are completely unestrained and both of them are reacting freely to the gravitational force.

If a spring balance and a test mass were allowed to react freely to the gravitational force (if they were in orbit together, for instance), the instrument could not measure the attractive force of the earth for the test mass. In other words, there would be no weight of the mass to be measured. Reacting freely (falling or orbiting) is the condition resulting in "weightlessness." The most common situation experienced in everyday life in which weightlessness is partially achieved is the starting phase of a descent in an elevator. Once the descent velocity has been reached, the motors restrain further fall; one realizes his full weight again.

NEWTON'S first law of motion defines a force in terms of action on a body. It is a purely descriptive expression and leads to the understanding that an accelerating body is experiencing a force. A falling body is accelerating. An orbiting body is accelerating. Any body reacting freely to a gravitational force is being accelerated by that force. There are three different entities being discussed: a force; a body possessing mass; the acceleration of the mass, produced by the force. Newton put these together in his second law of motion in a way that is useful in computation: the force is equal to the mass multiplied by the acceleration produced ($F = m \times a$). The second law, which is drummed into the head of every student of physics, states quantitively what happens to a mass when a force acts on it: it accelerates. The law says nothing of the nature of the force, so long as it operates on the body.

On the other hand, a formula stating the nature of a force expresses nothing about what it will do to a body on which it acts. The law for the behavior of frictional forces is entirely different from that for the forces of springs. Newton's law of gravitation describes the dependence of gravitational force on the quantities of material and the distances in the situation, but says nothing about the reactions of these bodies.

The entire description of the motion of bodies influenced solely by gravitational forces may be obtained by making an equation out of Newton's second law of motion and his law of gravitation. The complete mathematical solution of this equation involves extended use of the calculus, for it falls in the class known as differential equations (and results in six independent constants of integration that completely describe the orbit).



AN ACCELERATION is a change in speed and/or direction, caused by a force.

In spite of the need for advanced methods of treatment, the equation of motion (as it is called) can still yield interesting information through application of elementary algebra.

$$\overset{\textit{Action}}{m_1 a_1} = \overset{\textit{Force}}{-G \frac{m_1 \times m_2}{d^2}}$$

The action side of the equation shows the acceleration and the mass that is accelerated. The force side of the equation shows the same accelerated mass multiplied by the mass causing the acceleration. When both sides of the equation are divided by the accelerated mass, this quantity disappears from the equation.

$$\overset{\textit{Action}}{a_1} = \overset{\textit{Force}}{-G \frac{m_2}{d^2}}$$

The result means that the gravitational acceleration of a body is independent of the amount of material in it. "Each pound does its own falling."

How often one reads that a body remains in orbit because one force balances another! Nothing is further from the truth. It is in an orbit because of unbalanced forces. It is true that an equation was formed, and that both sides must balance or it is no equation; but actual forces were not balanced in this equation. A force was equated to the effect it produced, and this allows a complete solution to the problem of orbital motion.

Glib statements about balanced forces originate partly in misunderstanding everyday experience, and partly in misunderstanding Newton's third law. He stated that every action was accompanied by an equal action in the opposite direction.

In place of "action" one often reads "force." Thus the man in the chair pushes on the chair with a force equal to his weight, and the springs push on him with an equal force. The forces are equal and opposite, so he remains fixed. This is not an example of Newton's third law, but of his first law, when forces are balanced. "Forces" should not be read into the third law. The third law does apply to the man in the chair, in a more involved way.

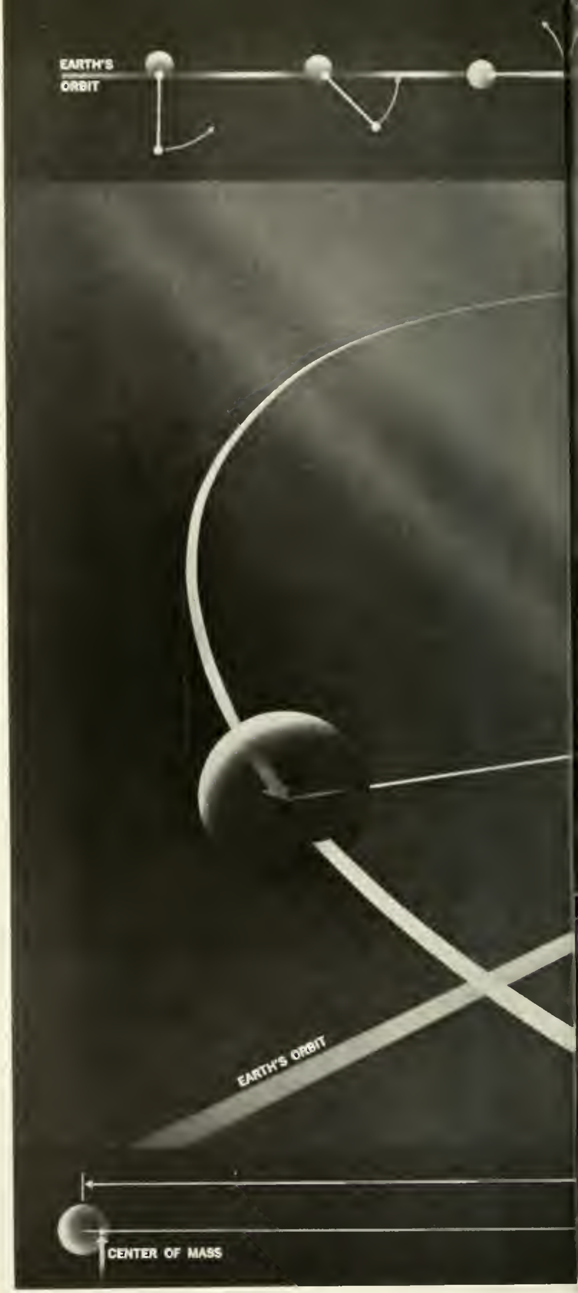
Recall that his weight is the force with which his mass is attracted by the earth, and also that there is a mutual force between any two massive bodies: the man also attracts the earth. His attraction for the earth is the equal and opposite reaction to its attraction for him. In discussing the equation of motion, one should now add a second equation expressing the earth's acceleration because of the man's mass.

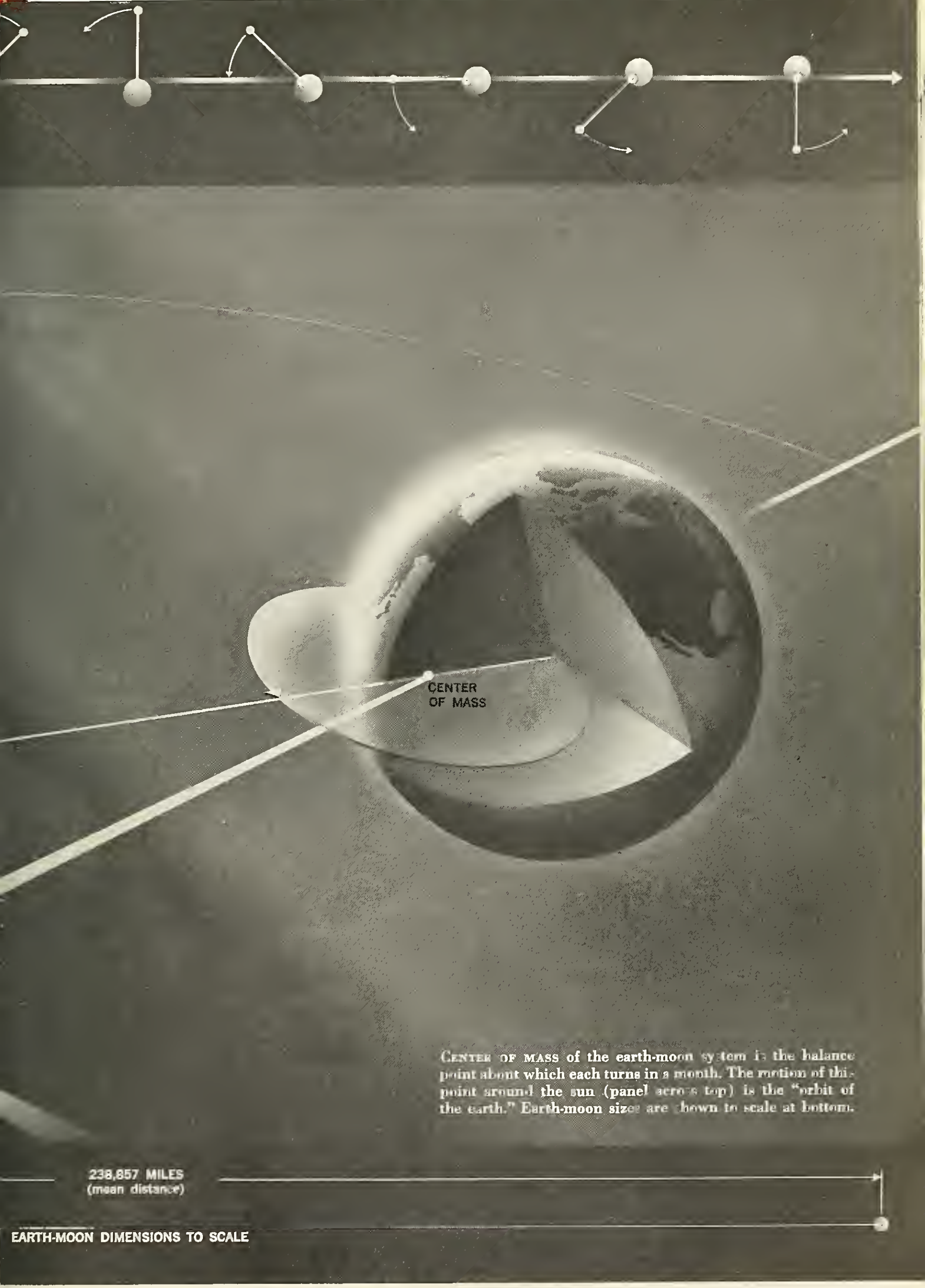
$$\underbrace{m_2 a_2}_{\text{Reaction}} = \underbrace{-G\frac{m_1 \times m_2}{d^2}}_{\text{Force}}$$

$$a_2 = -G\frac{m_1}{d^2}$$

True, it is not much, but it can be calculated. Seated in a chair on the earth, the man is obviously restrained from reacting freely to the gravitational force. An astronaut in orbit, however, is reacting freely in a manner described by the solution of the equation of motion. Now, the earth is similarly reacting freely and is in an orbit of its own, mirroring in miniature the orbit the astronaut is making. Together, they are both in orbit around their common center of mass. This is minuscule and can certainly be ignored, but not in the case of the moon in orbit around the earth. The moon possesses only one eighty-first of the mass of the earth, and it is nearly a quarter of a million miles away. Even so, the earth and the moon are revolving about a common point that is on the line between the centers of the two bodies and located about 3,000 miles from the center of the earth. The difference between the effect produced by the astronaut and by the moon is one of degree, not one of principle.

(To be concluded in November)




CENTER OF MASS
238,857 MILES
(mean distance)
EARTH-MOON DIMENSIONS TO SCALE

CENTER OF MASS of the earth-moon system is the balance point about which each turns in a month. The motion of this point around the sun (panel across top) is the "orbit of the earth." Earth-moon sizes are shown to scale at bottom.

Secrets from Cold

THE EARTH'S HISTORY during the past 800,000 to 1,000,000 years has been characterized by the alternate advance and retreat of vast, continental ice sheets, such as the one that now covers Antarctica. There were at least four such major advances, during which a quarter to a third of earth's land surface was blanketed with ice estimated to have been as much as 10,000 feet thick. The last of the great advances took place about 18,000 years ago. At that time, the continental ice sheet in the New World reached a point about 150 miles south of Cleveland, Ohio, and in the Old World reached as far as London, Amsterdam, and Berlin. The ice then began to retreat. Rapid final recession from North America, Europe, and Siberia began roughly 11,000 years ago. However, great ice sheets remained in Greenland and Antarctica.

The earth warmed up steadily from 11,000 years ago to about the end of the Stone Age, some 4,000 years later. During this climatic optimum, glaciers receded to their smallest size, but they began to expand again about 500 B.C. Another recession was apparent during the time of the Roman Empire, and was followed by yet another slow advance that lasted until approximately A.D. 1600. From 1600 to the 1850's the advance became more rapid, and actually threatened towns and farmland in the European Alps. Before there was any widespread destruction, however, the ice began to recede and, with local exceptions, has been melting continuously ever since. Because the earth has been getting somewhat warmer for the past hundred years, investigators at the beginning of the International Geophysic Year expected that the Antarctic ic cap would be found to be shrinkin This does not seem to be true. It ha been found that there is more ice i Antarctica than was formerly believe and this ice is accumulating in man places at rates varying from twenty two inches a year at Little America t seven inches a year at the South Pol Although there is a compensatory discharge into the sea, there is no evidence that the discharge is greate than the accumulation.

Antarctica, therefore, can b thought of as representing a "fossil Ic Age." The snow and ice that were lai down in most parts of the world during the great glaciations of the Pleistocene have melted away, and th layers are lost forever. But in Greenland and in Antarctica, it may stil

Storage

Messages from the past are read in polar snow and ice

By William J. Cromie

Sno-cat's tracks furrow snow surface on a vast ice shelf in the Antarctic.

be possible to study the variations in temperature and precipitation that led up to and succeeded these drastic climatic changes of the past.

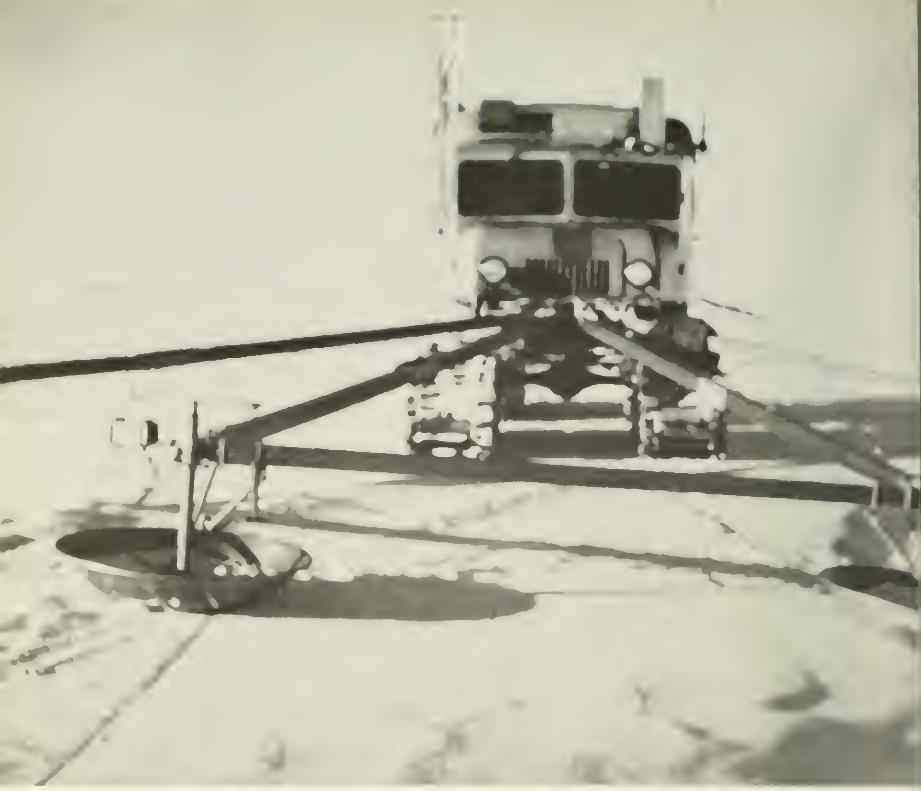
There are many theories that attempt to explain these changes, but none of them is completely accepted. Most theories point to variations in solar radiation; whether these variations arise from changes in the sun's heat output, or from changes in the position or the reflecting power of the earth is an open question. The answer to what caused the ice ages may not be found in studies of the deep ice, but an understanding of how these unknown mechanisms affected the environment is to be found there, and to understand effect is to go a long way toward discovering cause.

The study of ice is of growing importance in the consideration of current meteorology, historical geology, and the world's geographic and economic future. Meteorologically, in the simplest possible terms, when there is enough ice it affects the weather. It is in Antarctica, called "the world's greatest cold air factory," that most of the weather of the Southern Hemisphere is generated. In the Northern Hemisphere, the source of most cold air masses is the ice-covered Arctic Ocean. Intense low-pressure areas in the Arctic cause rain and turbulence as far south as the Caribbean Sea. There is evidence, too, that the influence of Antarctica extends to the Northern Hemisphere.

Ice affects the weather, but weather also affects the ice. The surface of the snow becomes the same temperature as the air. As air temperatures vary, the changes progress downward through the snow. In Antarctica, a cold snap that occurred some weeks in the past can be detected by an abnormally low temperature in snow layers a certain distance below the surface.

As the snow accumulates, succeeding layers are buried deeper and deeper each year and are eventually compacted into ice by the overlying weight. In this way an icecap is built up of layers, or beds, that may be a fraction of an inch to a few inches in thickness. These layers are revealed in cross section when a pit is dug into the snow. Taking the temperature of these layers in Antarctica is like leafing through old newspapers for local weather information.

Nor is this all. Temperature effects



ELECTRONIC CREVASSE-DETECTORS on long beams are pushed ahead of a Sno-cat, *above*. Temporary station, *below*, near the center of Ross Ice Shelf, was site of three-day series of gravity readings to record rise and fall of the floating shel in response to ocean tides. Glaciologists at the lower righ determine the hardness and the layering of surface snows

are exerted on the ice in such a way that a permanent record of local climate is impressed in the layers. At a depth of about thirty-three feet, for example, the temperature stabilizes at the average annual air temperature for a given location. This phenomenon is extremely useful for ice studies. Instead of establishing forty weather stations from the southern shore of the Pacific Ocean to the South Pole, collecting temperature data for a year, and averaging them for the mean, two men with strong backs and electric probe thermometers can traverse the ground in a few months and obtain the information with forty single measurements. A strong back is a prerequisite, because each thirty-three-foot probe hole is usually drilled by hand.

JUST as climate and ice influence each other at present, so must they have done in the past. Historically, climate is "fossilized" in the layers of snow and ice. Examining ice beds is much the same as examining rock beds. One difference between the two is in the time of formation. A rock stratum is laid down in thousands or hundreds of thousands of years; a snow stratum is deposited each season.

There are usually two seasons for deposition—summer and winter. Summer snow is different from winter snow. By measuring density and snow grain size, it is usually possible to distinguish one season's snow from another. The size of the snow grains is determined with a plastic card on which a grid is laid out in 1 mm. squares. The card is inserted into the layer of snow and the average grain size is quickly estimated by comparing grains with the ruled grid. This information, in conjunction with the layer's thickness, provides an idea of how wet and cold the season was when the layer was deposited.

Measurements of density and grain size yield information concerning changes of climate in the past, while temperature measurements reveal how the weather is changing today. Thus, the wall of a snow pit describes past climates in each stratum. The top stratum is today; it represents today's weather and this season's snowfall. The bottom strata—if we could reach them—might hold clues to the original formation of the ice and, in places like Antarctica and Greenland, to what the world was like tens of thousands of years ago.

Strain gauges measure distortion ice pressure causes in the walls of a South Pole ice tunnel.

Compression strength tests of ice cores show how much pressure they resist before breaking.

Glaciologists, working for a year at a time at permanent stations in Antarctica, have extended our knowledge back about 100 years by digging snow pits to depths of from 60 to 110 feet. In 1956, the U.S. Army Engineers modified an oil well drilling rig so that it could take cores of ice instead of rock. A corer has a hollow barrel: the cutting edge at its bottom cuts out a cylindrical section of ice, which is then brought up intact inside the barrel. By this method the layering is undisturbed and can be examined conveniently on the surface. The drill penetrated to 1,438 feet in Greenland and to 1,013 feet in Antarctica. Preliminary analysis of cores obtained gave detailed data on the climate of Greenland for the past 600 years, and of Antarctica for about 2,000 years, because there is less precipitation there.

Deeper penetration was limited by the presence of air enclosed under pressure far down in the ice. As this air was released by drilling, it shattered the cores and walls of the hole. The air is trapped in bubbles, and if enough can be brought to the surface it can be dated and analyzed to see if ancient man and other animals breathed an atmosphere different from that of the present day.

Recently, glaciologists drilled into Greenland's ice sheet at a spot some 6,500 feet thick—with a new device that melts its way downward. The thermal element is ring-shaped. As the ring melts the layers, the central column of ice remains intact, and a pipe above the ring envelops and holds the core. The thermal drill is intended to penetrate to a depth of two miles. It could thus reach the bottom of both

Unvarying pressure is applied continuously to compacted snow to test samples for deformation.

Long corers rest on a table in laboratory of snow mine. Short cores are kept on wall shelf.

the Greenland ice and, in some locations, the Antarctic ice.

It is important to learn exactly when a layer was deposited, when periods of heavy snow accumulation occurred, and how long they lasted. Here scientists turned to tritium (H^3), a radioactive isotope of hydrogen. In a fixed time tritium decays to normal hydrogen in snow and ice, just as uranium disintegrates to lead in rock. Tritium is suitable for dating ice up to 100 years old. In addition, it can be used in the upper layers to monitor fall-out. If dates of upper layers are determined by other radioactive elements or by layer counting, the expected tritium content for that age can be compared with actual tritium content, and the difference can be attributed to radioactive contamination from fall-out.

Besides monitoring fall-out by this method, scientists can obtain a fall-out record dating back to the time the first atomic bomb was detonated. Studying radioactive contamination in various areas of the earth also yields valuable data on the circulation of the atmosphere, which carries the debris from place to place.

The ratio of carbon 14 to normal carbon in the carbon dioxide of the air trapped in ice can be used to date ice as old as 45,000 years. Carbon dioxide in ice can also be used as a measure of industrial contamination of the atmosphere. This is done by a comparative analysis of recent layers and those that were deposited in preindustrial times.

When snow falls, everything suspended in the air falls with it, including dust and micrometeorites, plant spores, bacteria, and volcanic ash. In the ice cores taken in Greenland, the 1912 layer was identified by ash from Katmai, the Alaskan volcano that erupted that year. The ash from the 1883 Krakatoa explosion is being searched for at depths of 150 feet in Greenland and 60 feet in Antarctica. Similarly, unrecorded eruptions of volcanoes in isolated parts of the world can be dated if the age of the ice is known. This is done by comparing the mineral content of ash taken at the site of a suspected volcano with that present in the ice. The size and shape of the samples of ash grains found at the two sites can also be compared.

Once a reference level has been established, it may be a comparatively simple matter to count summer-winter pairs between the dated layer and any other point on a core or a pit wall. Below about 300 feet, however, the layering becomes obscured as a result of pressure. At greater depths, summer layers can be separated from winter layers by the relative amounts they contain of normal oxygen 16 and its heavy isotope, oxygen 18. The ratio of the two forms of oxygen varies with the rate of evaporation. The amount of heavy oxygen 18 will be greater in layers deposited during the warmer temperatures of summer than in those laid down during the winter. This technique enables ice scientists to determine the relative temperatures at which the ice was deposited and seasonal temperature variations where layering has been destroyed.

By all these means, it becomes possible to construct a detailed picture of past climates. The oldest layers that can be reached by present techniques, excluding the new thermal drill, date back barely 2,000 years. But in Antarctica the ice has been accumulating for perhaps 1,000,000 years. If glaciologists cannot bring up a sample of these deeper layers, they may at least be able to ascertain how thick the ice is, what quantity of ice is actually there, and perhaps what lies beneath it.

These questions can be answered by seismic reflection and refraction techniques. After the temperature has been read at the bottom of a temperature hole, the hole is loaded with dynamite. Explosive sound waves then go where the glaciologist cannot. When such sound waves were recorded and studied during the IGY, it was found that much of the land beneath the Antarctic ice sheet was below sea level. This finding has led to the discovery that Antarctica is not a single land mass, but a small continent and an offshore archipelago.

This seismic work has revealed that there is much more ice at the bottom of the world than was formerly supposed. Recent measurements show that the average thickness over an area of 5,000,000 square miles is between 6,500 and 8,000 feet, or as much as double the amount predicted by some glaciologists prior to the International Geophysical Year.

Thus, a number of clues to past meteorological and geological conditions lie buried in the ice. There, too, might possibly lie some indications of our geographic and economic future.

The average temperature during the Pleistocene glaciations is believed to have been 6° to 9° F. lower than at present. During the warmer, interglacial periods, it was apparently 3° to 4° F. higher. If these estimates are correct, we are now probably in a transition from a glacial to an interglacial period. The oceans now rise roughly four and a half inches per century.

Locked up in Antarctica is enough water to raise the level of the oceans by approximately 200 feet. The great weight of this amount of water would, after a considerable time lag, push the ocean floors downward, so that the net rise in sea level would be about 130 feet. It is a logical assumption that the Antarctic icecap is self-perpetuating and that, because of its location at the South Pole and its high altitude, it will remain stable throughout the interglacial age. However, even if it should melt at the same rate as other glaciers are shrinking now, it might be approximately 10,000 years before all the ice became water.

On the other hand, the melting of only a relatively small portion of Antarctic and Greenland ice could have a significant geographical and economic effect. A large percentage of the world's population is concentrated in low-lying coastal areas where large seaport cities have developed. A rise of only twenty-five feet in sea level would displace a considerable part of the world's population and endanger property that comprises much of the wealth of most maritime countries. A much smaller rise would inundate many low areas, such as Holland and the atoll islands of the Pacific, and would necessitate expensive reconstruction of many waterfront facilities throughout the world. Therefore, if the Antarctic ice should begin to melt, or the melting in Greenland should be accelerated, the change in the level of the sea could produce far-reaching consequences in the future.

While Antarctica is a large ice-covered land mass that is surrounded by water, the Arctic Ocean is an ice-covered sea surrounded by land. Water stores heat more efficiently than land, hence it is warmer in the Arctic. The floating ice there is only ten or eleven feet thick, compared to the great depths at the opposite end of the earth. There is evidence that the Arctic is warming up faster than the Antarctic, and recent data indicate that the northern ice has been melting for 100 years. A few more generations could conceivably see the Arctic Ocean at least partially free of the present volume of ice.

Some scientists think that such a melting would quickly precipitate a fifth Ice Age, as it would provide a vast new source of precipitation. However, if this did not prove true, North America and Eurasia would face each other across an open Arctic Mediterranean. This potential advantage to commerce and transportation might change the economic structure of the entire Northern Hemisphere.

All the ice in the Arctic Ocean does not have to melt to produce at least one major advantage. An open sea north of Canada—an ice-free Northwest Passage—would open up a new trade route with tremendous possibilities. It could make the resources of the Arctic more accessible and might open it to industry and even to agriculture.

On the Siberian side, the Russians have utilized the Northeast Passage since 1931. During the summer months, convoys move in and out of new Siberian seaports, and this former wasteland is on its way to becoming a populated industrial area.

There is another effect to be considered. If large areas of the Arctic Ocean become ice-free for even part of the year, a great deal more of the world's water areas will be available as a source of precipitation. The Northern Hemisphere would become wetter and warmer. This could make habitable areas that are now too cold or too arid, thus increasing the amount of productive land, food, and living space available for the world's rapidly expanding population.

If we are to predict what will happen to the world's climate in order to take advantage of, or to guard against, future events, we must understand how the mechanisms that change our climate operate. Icy regions are among the few places where we can observe how climate has changed in the past and obtain clues to how it will change in the future. Once we understand these changes and can predict them, we will have come far toward controlling both climate and sea level.

PLASTIC BOTTLE is filled with sno
from pit. Sample will be sent to U.
for isotopic analysis, which dates

Pink-headed Warbler

Seldom-photographed bird inhabits Mexico and Guatemala

By Walter Dawn

The pink-headed warbler *(Ergaticus versicolor)* and the other Mexican member of its genus, the red warbler *(E. ruber)*, are exceptions to the rule that red is missing from the basic color patterns of North American warblers. Both of these high-altitude, non-migratory species display the color abundantly, and they retain it throughout the year.

Pink-headed warblers are found on the central mesa and some adjacent crests of the Sierra Madre, in southern Mexico, and they range south to the highlands of Guatemala. In the spring of 1962 I roamed the central mesa, nine miles southeast of the town of San Cristóbal de las Casas, at an altitude of approximately 8,500 feet, trudging at least ten to fifteen miles per day over rough terrain. On April 17, I found a female pink-headed warbler completing a nest that was within a tussock of grass on a steep, cutover hillside. The nest, constructed by the female alone, utilized arching blades of grass for the dome. It was woven of pine needles, lined with lichens and moss, and was skillfully concealed.

While roving the epiphyte-laden pine-oak forests of the central mesa, I noticed many stumps of felled pines. The huge trunks are cut by Chamula Indians from nearby villages, squared by hand ax with machine-like precision into timbers eight inches square and about thirty feet long, and then sold in town for thirty-two cents apiece. As pines on the slopes are thinned, brushy areas are created for nesting. Madroña and oak, however, have a better chance for survival, and these are trees in which the warblers feed. The pink-headed shuns denuded slopes completely and is rare in the thick forest. The Indians, therefore, with their selective cutting, seem to be contributing to the warbler's spread.

Before and during the period from the completion of the pink-headed warbler's nest to the arrival of the first egg, the days were cold and dark, with repeated hailstorms. In the light of early morning, when clouds brushed the mountain peaks and the air was cold and damp, the head of the pink-headed warbler gleamed with a silvery luster against the somber background of the foliage. At this time the male did little singing. He followed his mate about and gradually shortened the radius of their movements around the nest—a maneuver that apparently induced the female to enter the nest more readily. One day, in a very dark glade within a heavy second growth of pines, I observed the male as he performed an inducement dance. His hoary head reflected the faint beams of light in an ever changing design as he flourished his tail while bowing and twittering before his mate.

In the territory of this male pink-headed—a rough rectangle about one hundred yards long and fifty yards wide—were found nests of six other species: a colony of band-backed wrens, rufous-browed wrens, blue-and-white mockingbirds, rufous-collared robins, russet nightingale thrushes, and painted redstarts. The pink-headed warbler had little contact with these birds, but he defended his territory against others of his species.

Early in the morning, on April 21, I found the first egg, which I marked. On the following two mornings the second and third eggs appeared. The first egg hatched as I watched on the morning of May 6, and the other two hatched on subsequent mornings, indicating a sixteen-day incubation period per egg. The female was the sole sitter and the male fed her frequently at the nest. Occasionally when the male approached with a mouthful of food he sang a subdued song that the female seemed to recognize. When she heard this song, and even before sighting her mate, she

Pink-headed warbler male feeds runt after other fledglings have left the nest.

Early morning light filters through oaks in nesting area of central mesa.

ADULT MALE, *top*, removes a fecal sac from nest, which contains three young.

OPEN BILL of the female, *above*, greets the male upon his return to the nest.

SOLE SITTER during incubation period, the female receives food from the male.

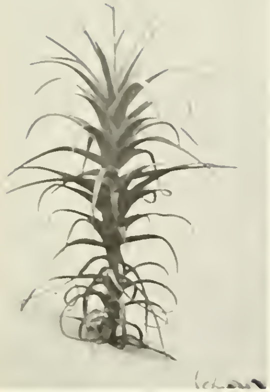
sometimes opened her bill as though in anticipation of receiving food. The male's normal, somewhat metallic song lasted one and one-half seconds and seemed to have a maximum of eight notes, blended harmoniously. Often a delightful, soft, melodic chippering flowed between the pair.

About 9:00 in the morning of April 24, I set up a camera equipped with a 250 mm. lens in front of the nest. After I left for the blind, the female immediately dove into the nest, but as she sat on the eggs, she apparently noticed the photographic equipment and flew out again. She returned thirty minutes later, feigned injury before the camera, and dragged her vibrating wings. She did not enter the nest again that morning, nor would she enter it the next morning. Rather than disturb her unduly, I waited until the eggs hatched.

AFTER the young appeared, both parents entered the nest without apparent trepidation. On May 10, about 2:00 P.M., rain clouds appeared. The hot sun vanished and a cold wind began to blow. Prior to the overcast the parents were feeding the young about once every five minutes. However, as the light failed rapidly, the feeding increased to two- or three-minute intervals. Both parents seemed highly agitated and chipped constantly. The young became so stuffed that finally they would accept no more food, but as the female perched on the rim of the nest with food, the male arrived with his. He could neither give it to the young nor pass it to his mate. For a few minutes both adult birds milled around helplessly until a movement I made in adjusting the camera frightened the male. The female then ate her food, fluffed her feathers, and settled down on the nest.

On May 11, the young warblers called for the first time. On May 15, two of the three young left the nest, having spent, respectively, ten and eleven days in it since hatching. The female then began to devote all her time to feeding the two, who were some distance from the nest. She did not return to the nest, in which the third young warbler—a runt—was still living. The male pink-headed fed the runt sporadically during the eleventh day of its life, but presumably the female neglected to cover it during the night—it was dead the next morning.

Female warbler perches on stem near the hidden nest that she constructed.



Tillandsia purpurea

Ecological Paradox of Coastal Peru

By E. Yale Dawson

"Sail the coast southward! When there no longer are any trees, you are in Peru!"

Such were the sailing directions given to early sixteenth-century navigators seeking from Panama the landfall to the Inca kingdom of gold.

The directions were surprisingly precise, for at Tumpiz, which was the northernmost coastal city of the Incas, a remarkably sharp line separates the forest vegetation of the humid tropics from the treeless desert. To the north the jungle extends, except for the semiarid Salinas Peninsula, through Ecuador to Colombia and Panama. To the south the vegetation fades quickly to the most meager scrub and then to absolute desert, which is almost without visible plant life for a stretch of over two thousand miles.

To those intrepid voyagers of the wind-lashed Peruvian seas, the utter desolation of this vast, rocky coastline pounded by breakers and backed by gigantic, bare mountains was as incomprehensible as their discovery of the towns, fortresses, and roads within it. Indeed, the Inca Empire had embraced all of this desert and accomplished some of the most stupendous feats of early American man.

Here and there, through V-shaped gorges in the coastal hills, turbulent streams that are born in the towering Andes flow to the sea. It was beside these waters that the peoples of Peru began five thousand years ago to build their towns and to spread water over the desert valley floors to grow their corn and manioc. By the year A.D. 1000, the Mochica civilization had completely dominated this arid environment and had built so extensive an empire that a single religious edifice commanded the use of 130,000,000 adobe bricks.

The use of these sun-dried bricks and the method of making them point to some of the remarkable features of this unique environment. Although often veiled by high clouds or by fog, the sun is always there. Rain does not fall. Sun-dried adobe is an ideal and durable building material in such a climate. To increase its strength, the early builders used the adhesive qualities of egg white. Where else in the world but Peru could a people find the millions of birds' eggs sufficient to bind the bricks of their cities? On numerous offshore islets dwelt the vast populations of sea birds that supplied both this building material and fertilizer for the fields. By the time the Tenth Inca had conquered the long coastal desert—before the voyage of Columbus—extensive cities had grown and major irrigation works watered the fields of corn and cotton and beans. So great and significant to the Inca Empire was the desert that a highway twenty-four feet broad was constructed along its length of over 2,500 miles.

A remarkable combination of natural features and forces created this environment, which shaped an ancient civilization, and now continues to support the descendants of the last conquerors. The study of these features, and the growing understanding of ways in which plants and animals respond to them, now enables man better to utilize his resources and to extend his occupation of the desert further.

The two principal causes of the coastal aridity are the mountains and the cool sea. The colossal escarpment of the Andes runs the full length of the continent. It is so excessively high that on its eastern side is effectively trapped nearly all the moisture that is pressed against it by humid air from the Atlantic lowlands. Most of the little moisture that does manage to reach the western slopes falls as snow on the peaks and, as meltwater, rushes down steep gorges to the sea. Above 10,000 feet only a treeless belt of grassy herbiage occurs. Below that level a marvelous assemblage of drought-resistant, succulent plants covers the precipitous slopes, but even the most tolerant of these give way to bare rock and sand at about 3,000 feet.

The sea's influence is nearly as great as that of the mountains. Up from the cold, far southern Pacific and hugging the western coast of the continent, the Humboldt Current sweeps to the Equator. As the Gulf Stream of the North Atlantic carries warm water far north to bring temperate climates to the high latitudes of Europe, so the cold Humboldt Current tempers the coastal climate of Pacific South America all the way to Ecuador. While the tropical northeast Pacific swelters in heat born of the warm sea, whose bordering lands are the *tierra caliente*, the southeast Pacific has none of this. Cool waters bathe that coast and have carried with them to the equatorial Galápagos Islands such unlikely animals for the tropics as sea lions and penguins. Not only does the Humboldt flow north with its cool water; this water is kept cool, despite incessant insolation along the desert shore, by the upwelling of colder subsurface water under the influence of prevailing southerly winds. The result is a unique phenomenon of the tropical world: a continental coast from the Tropic of Capricorn to the Equator along which the sea water is colder than is the air over the adjoining shore. A situation like this invariably results in coastal aridity even without the influence of other factors, but, coupled with the rain shadow of the Andes, the shores of Peru and Chile are doubly guarded from precipitation, to the extent that they receive essentially no rainfall as such. Such moisture as does touch this barren land comes in the form of fine mist or fog, the *garúa*, which shrouds the coast during much of the winter season—from May to September—and moistens the surface of sand and rock only enough to support the peculiar fog-desert vegetation of lichens and of species of *Tillandsia*.

The *garúa*, however, is not ordinarily sufficient to wet the soil enough to permit seed germination and the growth of rooted plants. Accordingly, except at a few favored localities, such plants are not to be seen in the coastal desert. Nevertheless, another interesting oceanographic factor does provide for occasional true rain in the north, and with it an unbelievable change, when the desolate shoreline turns to flowering greenery. Such times are "years of plenty" for the desert agriculturists, during which the long-dry coastal mesas and flats can be planted to cotton. These favored years come from the influence of another current, known as El Niño.

Along the far north coast of Peru, at the boundary of Ecuador, the Humboldt Current suddenly turns due westward and moves toward the Galápagos Islands, in convergence with the south-

Cool water of the Humboldt Current that moves northward along the coast of Peru, approximately to the western bulge of the continent, allows the existence there of animals such as sea lions (*Otaria byronia*) seen here in rich kelp bed.

Dried skeleton of an herb still stands on the parched soil, although it bloomed after the last rain in 1957.

ward moving warm waters from the region of the Gulf of Panama, which are also forced westward at this point where they meet the western bulge of the southern continent.

On the north, the warm current carries with it the characteristic tropical rainstorms of the jungle coasts of Colombia and Ecuador, while on the south the cold Humboldt stream effectively guards the coast from rain. This accounts for the sharp line of demarcation between the forest and the desert at Tumbes—the modern name for Tumpiz—in north Peru. However, the point of convergence of the warm and the cold streams is not stationary, but characteristically makes a slight southward shift at about Christmas time during most years. Because of this southward extension of warm water and the accompanying rain that falls on areas ordinarily in drought ten months or more each year, the current came to be known as El Niño, and was equated with the joy attendant on the coming of the Christ Child.

Thus, the coastal regions of south Ecuador and north Peru receive a quite regular, pronounced, but shortlived rainfall that has favored the development of a succulent and thornbrush vegetation capable of sustaining itself through long months of drought. The El Niño with its rains does not regularly extend south of Tumbes, however, and there begins the true desert. Nevertheless, there are such irregularities in the position of the Humboldt—El Niño convergence that occasionally, roughly at intervals of five to eight years, the warm current extends farther south for a brief period and brings rain as far as Piura or even Trujillo. Some of the finest cotton in the world is grown in north coastal Peru from plantings made during these occasional heavy rains.

One remarkably drought-resistant, surface-rooted plant, the cactus *Neoraimondia macrostibas*, is able to conserve water during all these intervening rainless years and to persist on the rocky hills as the only conspicuous, treelike plant of that region.

Still another irregularity of longer cycle occurs in the oceanic convergence and, rather than "years of plenty," it usually provides widespread disaster. It consists of a rare, far-southward extension of El Niño that does not quickly return to the normal convergence point off south Ecuador. This extraordinary displacement occurs two or three times a century and brings great changes to the established pattern of life on the land and in the sea—so much that the lives of men on the desert shore are drastically affected. The last great displacement occurred in 1925, and it was chronicled by the ornithologist Robert Cushman Murphy, who was there to observe the disaster in connection with the sea birds.

The rains began to fall in February and continued with brief interruptions for five months. The warm current spread southward all the way to Callao and, as it came, killed the marine life of the normally cold-water coast with its heat. Fish that did not succeed in moving southward fast enough died and were cast on the beaches in endless stinking windrows. With the destruction of the fish, the vast sea bird populations began to starve. Millions of birds fled south, but

Colony of lichens, which lives on fog moisture, grows on the spines of barely surviving cactus, *Haageocereus*, at left.

Barren, rocky hills of the coastal Peruvian desert are nearly destitute of plant life for over two thousand miles.

millions more died of starvation around their nests, where multitudes of eggs and nestlings were lost. Beaches and harbors were littered with carrion. The phenomenon of "The Callao Painter" appeared. The early Spaniards had given it the name, because such high concentrations of hydrogen sulphide developed from decaying bodies that the paint of vessels at anchor turned black. Thousands of tons of precious guano were washed from the bird islands into the sea. With this nitrification of the water, together with the pollution from its dead inhabitants, came a "red tide" —dinoflagellate blooms that seemed to streak the sea water with blood.

On the land, terrible erosion of the already barren soil occurred, together with destruction of the weakly roofed adobe dwellings of the people. Their supply of fish gone and the normal transport of supplies cut off by communications wrecked by flooding, the people began to starve. Standing pools of water bred mosquitoes; malaria broke out among those who had not known it in a lifetime; and typhoid resulted from suddenly contaminated wells. Even the rats became starved from disruption of accustomed food supplies, and in their weakened condition began to die of plague, which spread to men who lived in squalor with them. So badly were railways and roads destroyed by the incessant rains that in Lima files of llamas were, as in ages past, driven down from the sierra bearing loads of foodstuffs for the city. But then in June the cold water reappeared; the rains stopped; flowers bloomed and died in the sand; fish and birds returned; the sun came out to bake the land; and it was desert again.

In all of this we see a remarkable contrast in life on the land and in the sea of Peru, depending upon sea-water temperatures. The cold water of the Humboldt stream supports rich marine life that cannot tolerate the high-temperature, low-oxygen waters of El Niño. On the other hand, the all but lifeless desert shores burst into greenery and flower with the warm tropical rains. In one the limiting factor is water; in the other it is oxygen.

In the sea neither water nor carbon dioxide are normally limiting for the growth of algae that are the pastures of the oceans. During daylight hours the seaweeds and phytoplankton produce food and oxygen used in respiration, but at night oxygen is often of limited availability while respiration goes on. Accordingly, it is in areas of high oxygen concentration, whether in colder water where the solubility is higher, or in surfy places where more atmospheric mixing occurs, that the richest developments of marine plants are found. Along the desert coast of Peru both of these conditions are met, and we find an abundant vegetation in the sea. This, in turn, supports enormous populations of marine invertebrates, fishes, and fish-eating birds and mammals.

On the land, where water is the limiting factor, we find that the climax vegetation usually consists of the most elementary phases of plant succession. One often thinks of succession in terms of gradual development of a plant-supporting soil, beginning with bare rock upon which crustose lichens begin to grow, followed, as the soil buildup proceeds, with mosses, annuals, shrubby perennials, and finally forest—provided, of course, that water is available. Here, however, the intense aridity provides little further advance in the composition of the flora than rootless plants capable of surviving on the ephemeral surface wetting provided by the *garuas*. Several kinds of plants have successfully met these difficult conditions and persist on the desert with the most meager moisture.

ONE of these is the blue-green alga, *Nostoc*, which lives most of the time as dry, black granules and crumbs loose on the surface of the ground, dehydrated to the extreme, but holding a residue of life in its drought-resistant aplanospores. With the coming of *garuas*, these crumbly fragments expand as the colloids of dead cell walls absorb the moisture. The aplanospores germinate and spread a skein of filaments that covers the ground with a dark, glistening slime so long as mist or puddle remains. Then they shrink, dry, and crumble to await a future rebirth.

Similarly, the lichens on bare rocks survive by this technique, but instead of alga alone, the food-making alga is surrounded and protected by interlaced filaments of fungus that may assume the most bizarre forms. This association of plants grows only during the time of moisture, adding cellular material that acts as a sponge to hold and conserve water even after the plant is dead. Thus, the lichen may consist largely of dead cells or filaments that serve the living ones by their absorbent qualities.

Throughout most of the Peruvian coastal desert the lichen is the most advanced component of the flora, and often there is a great diversity of species, from thin, crustose ones to intricately branched, bushy, or foliose ones, that catch and condense any droplets of water from a sea-borne fog.

Apart from these algae and lichens that persist by alternately growing and then retreating into minute, resistant spores, two other kinds of plants survive perenoially by means of highly efficient adaptations for water absorption and conservation. The most widespread of these on the central Peruvian coast are species of *Tillandsia*, related to our well-known Spanish moss (*Tillandsia usneoides*), and more distantly to the pineapple.

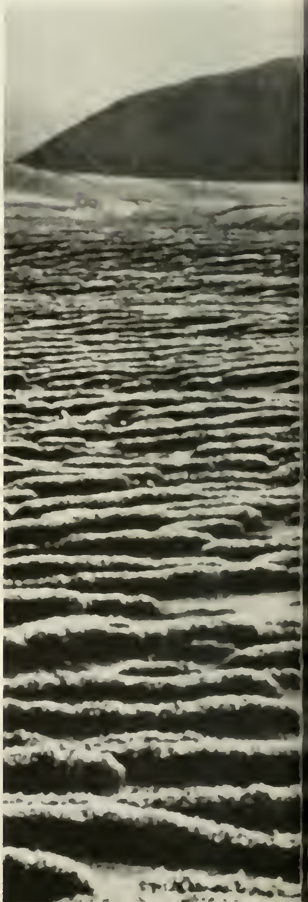
Tillandsia occurs in great, dark patches on soilless sand hills throughout the coastal desert. It needs no soil, for its roots are only briefly functional for anchorage of young plants and, indeed, are essentially absent in older ones. *Tillandsia* is truly an "air plant," and here in the Peruvian desert is strictly a mist-catcher. Its leaves are so arranged that during *garua* season the moisture, condensed on minute epidermal scales, runs down into small catch basins at the leaf bases, where specialized absorptive cells take it in much as do root hairs in other plants. Once the water has been absorbed by its succulent leaves, it is vigorously conserved over the ensuing dry months by an impervious epidermis. So effective is this conservation that even as the hot, parched summer is well advanced, tillandsias may be found using a little of their reserve water to send up a flowering shoot for the fulfillment of their reproductive functions.

In a few favored spots another perennial plant succeeds in a life dependent upon roots. This is the cactus, and it is scarce indeed on the very dry coast, for there are few places suitable for a shallow-rooted plant. However, on some rocky hills the presence of smooth, shalelike rocks permits the least precipitation to run from the rocks to cracks between, wherein the roots of *Haageocereus* quickly pick up all that reaches them and immediately store it in the hydrophilic tissues of its water-impervious stems. Such plants scarcely grow at all, except during the rare years of appreciable rainfall, during which the seeds also may germinate, and a young plant now and then survives under a protective rock long enough to receive the marginal sustenance of the next *garúa*.

THEN, of course, there are the numerous desert annuals that meet the problem of survival somewhat like the alga—by going into a drought-resistant stage. But these are not true "annuals" here, for their seeds may lie on the parched ground for ten years or more without receiving sufficient moisture for germination. The last time there was a flowering of annuals in the coastal hills around Lima was in 1957. The extraordinary longevity of many of these minute seeds under the most severe conditions of heat and drought is one of the most fascinating of all the desert phenomena.

Whereas the life of the land is so frugal, so scant, and so ephemeral, that of the sea is rich and varied and free. The shallower waters of the rocky shores teem with invertebrates and fish among dense beds of kelp and sea palm, while the offshore waters support so rich a plankton that great schools of anchoveta abound, followed and fed upon by guanay and tuna.

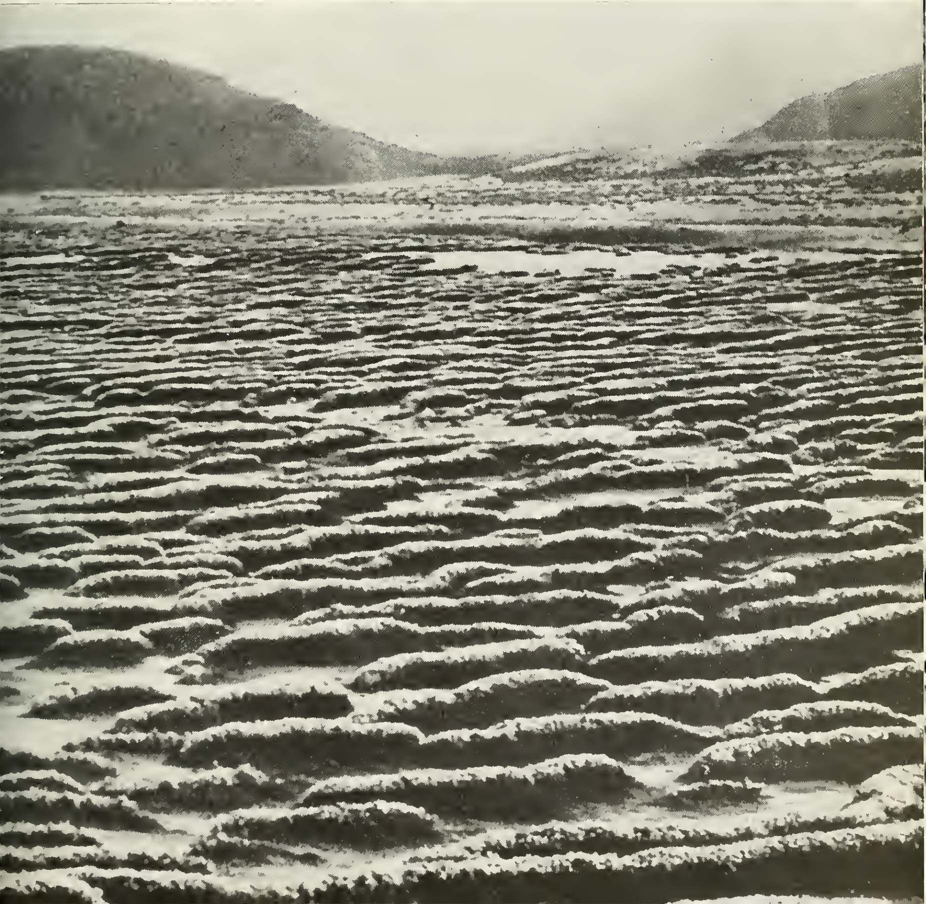
The vegetation of the inshore waters is of special interest, for, despite a latitudinal displacement of some twenty degrees, one sees in it much resemblance to the temperate northeast Pacific marine flora. Thus, at Lat. 12° S. the intertidal flora of the Lima area corresponds closely with that of southern California at Lat. 32° N. The genera are for the most part identical, and even some of the same species are present in each of the areas.



YET, we cannot go far with the comparison, for even now, in the secd half of the twentieth century, we e only just exploring this Peruvian ast for its marine plants. Only a action of the species have been rerded in the botanical literature to te. and these essentially only from tertidal and driftweed collections om a few localities. The flora of the fratidal belt along this rugged coast s yet to be obtained and studied. But are now in the age of the Scubaving botanist who one day will help complete man's exploration of this sert shore—an exploration that was gun on land five thousand years ago the earliest Indian agriculturists.

Mounds of *Tillandsia*, wetted by fog, grow wavelike on sands close to Lima.

Lichen crumbs and crusts, *above*, will expand and grow when fog-drenched.



Hunza in the Himalayas

Storied Shangri-La undergoes scrutiny

Terraced country, *left*, is ruled by the Mir, shown with village chiefs, *above*, at his palace at 8,000 foot altitude. Background peaks exceed 20,000 feet.

By John Clark

The following is an entry in my weathered notebook of a decade ago, written when, as an American living in the Himalayas in a run-down castle, I was operating an infirmary:

"'Salaam aleikum, Hazoor! my trouble is very great,' said old Bohar. He raised his white-stubbled chin and pointed to the source of his pain.

"I looked and shuddered a little. Four oozing, open holes, each the diameter of a pencil, pierced his chin and jawbone. I asked him to open his mouth, and he complied, exposing a row of teeth worn absolutely flat. I ran my finger across his lower teeth; four were so loose that I was able to pull them out with my fingers. Bohar gasped, then relaxed as the extraction permitted the abscesses at the roots to drain more freely."

This was in Hunza, the small, mountainous, Central Asiatic kingdom bordering on China, Kashmir, and Afghanistan, about which there has been recurring publicity, characterizing the land as a Shangri-La peopled by men and women of extraordinary health and longevity. Since the beginning of man's role as a traveler, tales of far-off earthly paradises have been brought home to entertain the untraveled. No matter how many such El Dorados perish under examination, the next is inevitably welcomed into the lists with unblemished credulity.

FABLED ELDERS of Hunza are products of rugged mountain life, scarcity, Moslem faith, and an autocratic tradition. If they exaggerate age, it is done to claim society's veneration.

SEGREGATION of the sexes is rigid from early youth. Hunza's Moslem girls, *right*, are destined to live almost totally dissociated from the lives of men. Here two eat chapatties.

In Hunza, say the romanticists, a race of Moslems—descended, according to their traditions, from the lost legions of Alexander the Great—exist in a Himalayan paradise, thrive on simple foods, live a life free of the corruptions of Western civilization, and reach ages of 120 to 140, the men still fathering children when more than 90 years of age. After being exposed to the realities of Hunza life, one feels more than a sense of irony when he comes upon these representations of a way of life that is among the bitterest in Asia. The "Healthy Hunzas," the "Democratic Court," and the "Land Where There Are No Poor" — almost all of this is born of too-hurried observation by Western tourists.

Politically, Hunza is a protectorate of Pakistan, which controls its foreign affairs, its defense, and its single telephone line. Hunza pays no taxes to the Pakistani Government. Instead, they are paid to the Mir, who is absolute ruler of the small border state. The Mir appoints an *arbop*, or village chief, and a *choukidar*, or local sergeant at arms, for each village. Local disputes are tried by village chiefs. Anyone has the right of appeal to the Mir's court, which consists of the Mir, his hereditary grand vizier, plus the Mir-appointed chiefs of all the villages within walking distance of the palace. However, since the loser usually pays a fine to the Mir's treasury, and the winner traditionally gives the court a present equal to the loser's fine, not many cases are appealed. The Aga Khan (literally "Grandfather King") is spiritual leader of the Ismaili religious sect to which all Hunzas belong the Mir of Hunza is administrator, bu not religious deputy, for the Isma lians of the Central Asian District.

THE notes about Bohar and hi teeth were made after I ha worked with the Hunza people for almost three years during two prolonge stays in the small kingdom. I was introduced to this part of Asia as reconnaissance engineer on Genera Stilwell's staff, and returned twice between 1948 and 1951. My primar purpose as Director of the Centra Asiatic Research Foundation was t discover what resources were availabl to the Hunzas, and to teach them t use these to their own best advantage From the start of my second visit operated a general dispensary wit

Mir's daughter, the Princess Nilofar, is spokesman for Hunza's women, who, despite public segregation and their low status, never are forced to marry against their will.

/estern equipment. (Training in anatmy, some concentrated informal tudies of Asian diseases, plus preious experience, made this possible or me. In addition, I ran three experiental gardens and founded a craft chool. with the Mir's approval.)

Bohar had developed scurvy, after hich staphylococcus infected the ums and abscessed the roots of his eeth; the abscesses had then eroded ownward through the jawbone and ut through the flesh and skin. After ashing out the sores, I gave him vitain C tablets to stop the scurvy, and itamin D with calcium lactate to cure he rickets that were stiffening his nees. The old man was by no means typical. My dispensary was always eset by lines of waiting patients, all vith afflictions that belied popular beliefs about "the Healthy Hunzas."

Altogether, I was able to treat 5,680 medical cases—the country had no other dispensary—during my stay in Hunza. My daily group of patients did not suffer from many of the diseases common to our civilization. There were no true neurotics; no cases of stomach ulcers, appendicitis, or gout; only one case of cerebral hemorrhage, and but four cardiac cases. The few bad hearts had been damaged either by malarial anemia or by overexertion at high altitudes, as was the case with one man who had carried the Mir's piano on his back up twenty miles of mountain trail. On the other hand. my Hunza patients did have malaria. They also had at least two kinds of intestinal worms, and to see for the first time a man with *Ascaris* worms impacted in his duodenum is appalling. The disease is more painful than the ulcers Hunzas do not have. Hunzas also suffer from trachoma, pneumonia, tuberculosis, a fatal type of dysentery, and violent staphylococcic infections of their eyes, teeth, and skin. I never observed cancer.

Total blindness, too, often afflicts the Hunzas and is caused by staphylococcus infections, cataracts, and pterygium. (More than five per cent of the population had trachoma.) I cannot forget the father who brought me his nine-year-old daughter with both her eyes horribly swollen from staphylococcus. They came the day after I had run out of antibiotics. The next shipment arrived by caravan two months later when the little girl was permanently blind.

Family life on Hunza's flat roofs bespeaks the country's dry climate and the cramped quarters that prevail inside a typical stone abode, forcing inhabitants to seek increased living space in the open. A meal is being prepared, *above.*

One evening, I took a census of the nine teen-age boys in my wood-carving school. Of these, all from well-to-do households, how many had seen death in their immediate families? Here was the roll:

Gohor Hayat: mother, three brothers, two sisters; Sherin Beg: one brother, one sister; Nur-ud-Din: mother, two brothers, two sisters; Md. Hamid: mother, one sister; Burhan Shah: one brother, one sister; Nasar Md.: mother, two brothers, one sister; Mullah Madut: two brothers; Suleiman: one brother; Ghulam Rasul: father. In a country fabled for the long lives of its inhabitants, these are depressingly typical Asian statistics. Moreover, there is little reason to believe that any of the old men are really as old as is claimed.

"How old are you?" I once asked a venerable patient.

"Ninety, Hazoor!" he answered.

"How do you know you're ninety?"

"Well, Hazoor, my hair is white, and I know I'm very old, and ninety is very old, so I must be ninety."

My teen-aged assistant, Gohor Hayat, broke in impatiently, "Why do you waste time asking such questions? You know there are no records, because so few of my people can write!"

I had thought the old man might have a way of keeping count. "How old are you, Gohor Hayat?" I asked.

Gohor Hayat responded loftily, "I'm

Craftsmen like this weaver are not numerous in Hunza; the demanding mountain economy requires the full-time effort of the society to raise food.

CENE MORE TYPICAL of neighboring Gilgit than of Hunza s this one showing boys at a community fountain. Until a short time ago, little if any pipe had been available in Hunza. Water, called "glacial milk," comes from ice sheets.

RINDING of barley and wheat, *above*, s done by centuries-old technique.

HAPATTIES are the end product of he country's milling and baking.

seventeen." Two years before he had told me he was thirteen.

Because the Hunzas, themselves, have no written records, I attempted to estimate longevity on the basis of physical signs of age.

THE elderly Hunzas, I discovered firsthand, show impressive dental evidence of being no older than sixty to seventy-five, not an unusual old-age in Western countries. Owing to a lack of vitamin D and milk in their diet, the great majority of Hunzas have soft teeth. A young man of about twenty-one, just cutting his wisdom teeth, typically has six-year molars that are worn flat. This allows a rate-of-wear calculation that is relatively dependable in determining age. For instance, a man over one hundred years old, at this rate, would have all his molars worn down to the jawbone, but this does not occur even in the teeth of the very oldest Hunzas.

"Purity" has been attributed to the Hunza diet, but the diet itself has seldom been more than superficially observed or related to its highly seasonal pattern. In the summertime the Hunza cuisine is limited, but not too bad. Chapatties—shaped like pancakes and made of coarse, whole-barley flour and water—form the staple, and salted tea is the beverage. Mulberries, fresh apricots, cucumbers, and occasionally sheep-milk butter, round out the meals. By September, wheat replaces the barley, and fresh grapes, carrots, and some melons are available. The grapes are either eaten fresh or made into wine; the supply of both is always exhausted by spring.

Tumushuling, the great winter celebration in mid-December, is a sort of delayed thanksgiving feast. December 19, the day before the Tumushuling celebration, is the day in Hunza on which all weddings are celebrated. Each bridegroom, accompanied by several of his friends, goes to the home of his betrothed and sits outside her door, which is kept partially open. Periodically, he hands in gifts of cloth, food, or perhaps even a dish or pan from Pakistan. Meanwhile, his friends give chapatties with butter, a real luxury, to any wayfarers who may pass by—a custom that encourages some travelers to take circuitous routes in order to encounter the well-to-do marriages. By evening the gifts are exhausted and the groom returns home, leading his veiled bride, who either walks or is mounted on a donkey. Tumushuling thus is a group wedding celebration as well as a harvest festival. The Mir gives a small gift, usually a piece of cloth, to every bridegroom who comes to claim it.

As in most Asian cultures, Hunza marriage is civil rather than sacramental. The ceremony is really a not-too-symbolic purchase of the bride.

Marriages are not arranged against the will of either party, and although divorce is legally very easy for men or women, it is not common. Women are neither abused nor overworked, and the mother is the respected chief of the house, as the father is of the farm. Marriage does not encompass companionship as we know it: men spend their spare time in the company of other men, and women visit exclusively with other women. They hold their dances on separate threshing floors a half-mile or so apart, on the same night, and woe betide the eager teen-age boy who dresses in his sister's clothes and sneaks into a girls' dance.

At the time of the Tumushuling, and only then, Hunza families butcher a sheep or two; cold weather preserves the meat for the few days before it is all eaten—and it *is* virtually all eaten. Even the long bones are cracked to extract the last marrow. After this taste of meat, the winter of the dietary year sets in. Gradually the supply of carrots and potatoes fails, then the wheat, the barley, the dried apricots, and the tea. By springtime the poorer folk may eat only once in two days. No one starves to death, but no one has enough to stop hunger.

The regular Hunza diet has no fats, no animal proteins, no vitamin A, no vitamin D, a deficiency of vitamin B, and a serious deficiency of calcium. Apricots contain some sugar and vitamin C, but the poorer families are unable to raise large crops. (The size of apricot orchards determines a man's wealth and status.) Hunzas use every bit of the apricot, as they do of the sheep. They cut the pits from the fruits, crack them, and remove the almond-like nuts. The women hand-grind these with stone mortars, then squeeze the meal between a hand-stone and a flat rock to express the oil. Apricot oil is fuel for the saucer-shaped lamps that illuminate their homes, as lamps of this type have done since the Bronze Age. The oil is very bitter, naturally enough, because of its high content of prussic acid, fifty drops of which are said to be lethal in about four hours. Men add a few drops, as bitters, to their wine, and occasionally a despondent woman takes a dose in order to commit suicide.

Mild cases of rickets and scurvy are rampant every spring—not enough to kill, just enough to loosen teeth, cause aching knees, and deform ribs into the "fine, barrel chests" reported by travelers. (I found that when they took off their shirts the fine, barrel chests revealed strong asymmetry, with ribs notably warped by rickets.) During my first winter, I developed a typical case of beriberi, even though my diet was more varied than theirs and was adequate in quantity.

The basic trouble rests not with the Hunzas, who are neat, intelligent, and hard-working, but with their country. There is no flat land in all of Hunza. Villages and farms are built on alluvial cones—fan-shaped masses of gravel dumped by streams rushing from mountain glaciers down into the valleys—and the small cultivated areas simply are not extensive enough to support the constantly increasing population. (The Mir estimated the population of his country at 25,000 in 1951. According to one of the last of the British agents stationed in nearby Gilgit, Hunza's population was increasing at the rate of 30 per cent each decade. Rising emigration and the absence of written records obscure the reality, as one might imagine.)

Hunza's slopes are so steep they must be terraced by the laborious construction of hand-built retaining walls of boulders. I measured one cultivated slope of 60 degrees—so steep that the retaining walls were twice as high as the miniature plots they supported. And sometimes Hunza farmers will even create arable soil on top of bare rock. After a crescent-shaped wall at the foot of any fairly gentle rock slope is built high enough so the top of the wall is level with the top of the slope, the wall is carefully chinked and mud-calked, then sandy water from the nearest irrigation ditch is admitted to make a small pond. When the sand settles out, the clear water is drained, and more sandy water is admitted. This process is repeated for about two years, until enough sand accumulates to allow cultivation.

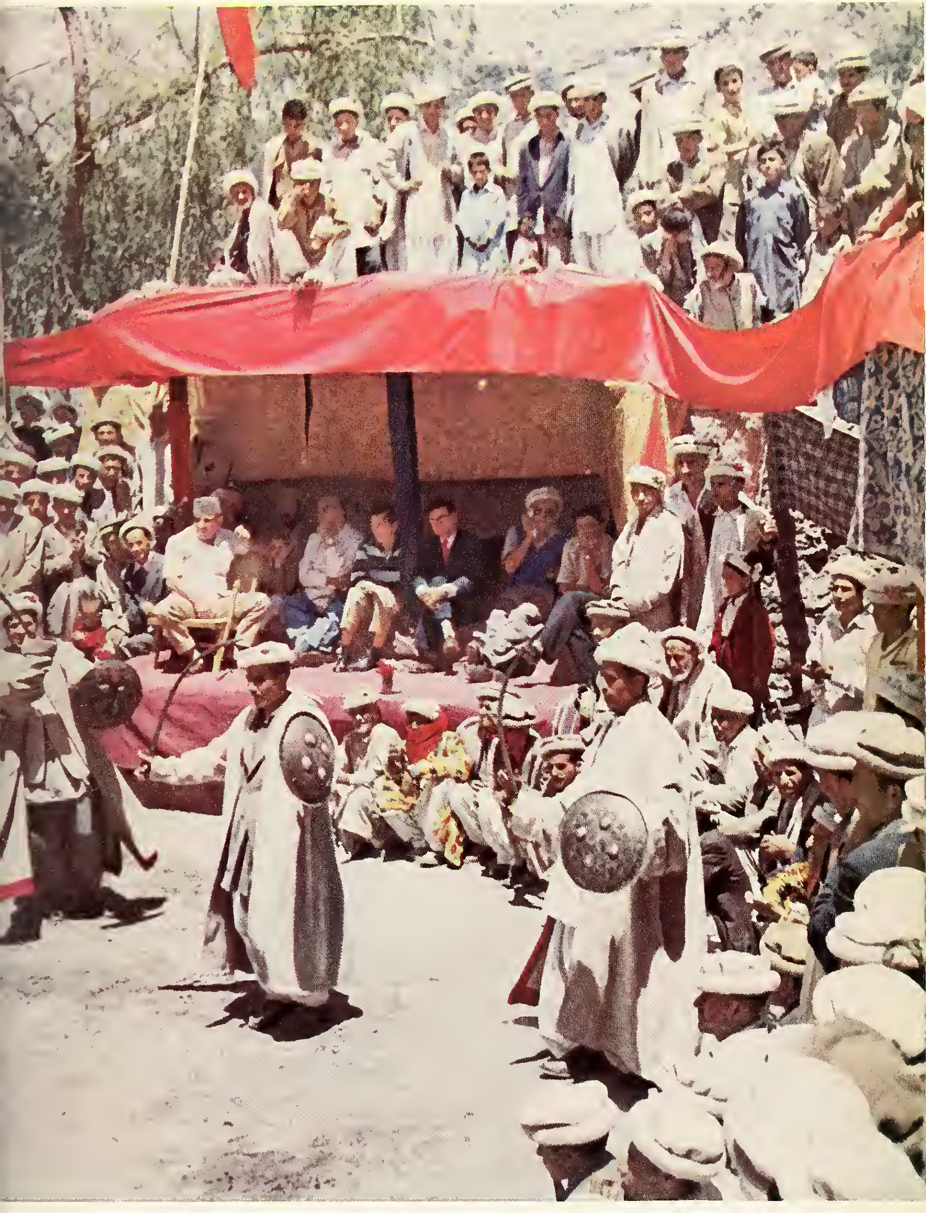
Much of the "soil" of Hunza fields is thus not really soil. Rather, it is a jumble of unweathered boulders, gravel, and sand. Since Hunza is a cool but exceedingly dry desert, practically no plant food is formed. The scant rain that falls soaks rapidly through the spongy sand, leaches out any trace of plant food that may be present, and carries it down to the river. Not even sagebrush will grow on the unirrigated areas, so most slopes are barren. Newly irrigated areas are so sterile that Hunzas have told me, "If you irrigate new land, you must eat for five years somewhere else."

Hunzas are skillful at building a limited fertility into their sterile material, given enough time. All sheep manure is carefully saved, and the fields are fertilized with it four times during each growing season. Frequent irrigation works with summer warmth and mountain ozone to decompose the manure rapidly. The growing plants thus have a few weeks of available food after each fertilization, before drainage again removes the plant food. Hunza farming is actually hydroponic gardening, with the soil functioning merely to anchor the plants.

Plainly, the plants will receive enough of only those foods that occur abundantly in sheep manure. Nitrates, phosphates, and probably calcium are deficient. Yields of wheat and alfalfa are notably lower per acre than are yields from better-fertilized American acres. Apricot trees generally have reddish leaves at the growing tips, a sure sign of soil deficiencies.

Even the most painstaking hydroponic gardening cannot compensate for deficiencies in the food chemistry. Moreover, their system makes Hunza one of the few countries where an agrarian economy is absolutely dependent upon the pastoral economy. Even in the high mountain summer pastures, the sheep are carefully herded into small cotes in order to preserve each night's droppings. Every few days a man climbs down the steep trail with a load of manure on his back. Effectively, the fertility of the high mountain pastures is being transferred down to Hunza's fields.

Unfortunately, the human population has already grown so large that the fields cannot provide sufficient food. Hunzas are moving out of their country in rather large numbers. Although the exact total of annual emigrees is unknown, it is clear that most of them go to the lower villages near Gilgit, where they soon displace their less industrious Sheena predecessors. Hundreds of Hunza's young men join the Pakistan army. Others take work as servants, where their honesty, industry, and common sense make them highly valued. The Hunzas realize, as certain Western tourists do not, that their country is a land of little food, and even less opportunity for the future, picturesque as it is.



CELEBRATION of wedding ceremony is enjoyed exclusively by male participants and spectators. Segregation of the sexes prohibits women, including bride, from viewing ceremony. On many public occasions, women hold a separate gathering.

Enigmatic Lizard

Pygmy chameleon is one of few species to store sperm

By Otto von Frisch

Until recently, the fund of biological knowledge concerning the South African pygmy chameleon (*Microsaura pumila*) was necessarily limited because it was nearly impossible to observe the reptile closely in its habitat, and pygmies brought into laboratory terrariums proved difficult to sustain for more than a few weeks. Uncertainties about what comprised proper food for this tree-dwelling animal, what were its most favorable environmental temperatures and humidities, and what conditions best facilitated its breeding activity went unresolved for years. As of today, there are a modest number of cases in which herpetologists have succeeded in keeping pygmy chameleons alive in captivity for long enough periods to allow a start in answering some long-standing biological questions.

My own observations began when I acquired several pygmy chameleons immediately after their arrival in Germany from Africa. My adult males attained a length, including tail, of about 11 cm. (4⅓ inches). They were somewhat smaller than the females, which typically grow 2 to 3 cm. larger. Other chameleons, like the well-known *Chamaeleo chamaeleo* in North Africa, Syria, and southern Spain, grow to about 30 cm., while Madagascar's *Chamaeleo oustaleti* sometimes reaches 60 cm. Thus, *Microsaura*, only one-fifth as long as the Madagascar chameleon, is aptly termed a pygmy.

Usually these "lizard gnomes" are light green in color, with a series of pale blue and pink spots along the sides of their bodies. On the head, above the eyes, two more colored spots appear, one above the other. The pygmy chameleon will change in color from yellow-green to a very dark shade of gray, depending on whether it is day or night, on the temperature, and on the animal's general "mood." Young range from light to dark brown, and are spotted or lined in dark shades on the sides of their bodies. After about three weeks of life, they take on the green adult coloration.

To keep the pygmy successfully in a terrarium, it was necessary to simulate the conditions of its natural habitat. The first, and one of the most difficult steps, was to provide suitable food. Large chameleons, like *Chamaeleo oustaleti*, can seize small mice with their sticky, projectile tongues and ingest them easily. However, the pygmy chameleon feeds on flies, spiders, house crickets, and other small insects, which must be stocked in the terrarium in a quantity far in excess of the amount that will be consumed, for the animal is not an active predator. It moves slowly among the twigs, avoiding quick movements that would attract attention. This is protective behavior; if frightened, the animal can run relatively fast.

Normally, *Microsaura* will sit quietly and wait until its prey comes within range of its tongue. Test experiments have shown that the chameleon has an optimum, or "preferred," distance from which to strike; this distance varies with the chameleon's own size and, perhaps, with its age. Adults normally shoot from a point 4 to 5 cm. from the prey, while the young attempt to strike from a lesser distance—generally 2 to 3 cm. Rarely do the adult pygmies miss their targets. Neither young nor old will attempt to strike at running or flying insects; instead they select a motionless insect. My own observations suggest the possibility that the newborn young may require time and repeated experience before they become proficient hunters. In their initial attempts, they often shoot too low and miss the target. Within a few days of birth, however, the young strike as accurately as do adults. When the prey is hit, it is pulled back to the chameleon's mouth with the tongue and there seized in the jaws. Small insects are ingested whole, while large victims are taken by the head and bitten during ingestion.

Feeding is a delicate problem. Large insects will frighten off adult chameleons, and the mere presence of spider webs will usually be enough to elicit alarmed behavior from the young. If just a single thread touches their skin, they scramble to the opposite end of the terrarium. A young animal 2 cm. long could easily become entangled in a web or could be victimized by large spiders, wasps, and other predators.

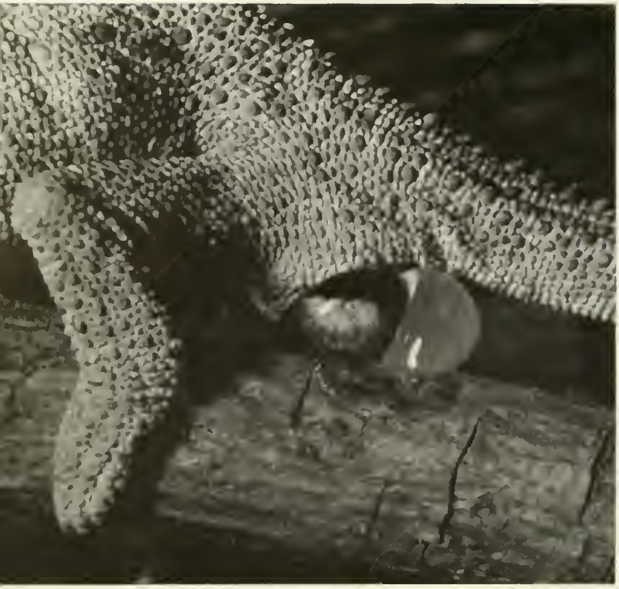
As a rule, the captive chameleon refuses to drink from a vessel. I placed a glass of water on top of my terrarium and strung a piece of wool down from the water to the level where the chameleons lived; thus they could lick "raindrops" from the moistened wool at any time. The summer terrarium was more or less open, and was placed in and among plants growing in a 2 x 2 m. box next to a sunny window. Therefore, my Lilliputians initially had the prey, water, and warmth appropriate for the undertaking of life.

Almost at once the males began to show typical threatening behavior. Confined to a relatively small area, their paths often crossed, and at such times they would move toward each other, shaking their heads and flattening their bodies. Males fight vigorously and may inflict serious injuries; females are generally less hostile.

This original pygmy community, made up of two individuals of each sex, unfortunately did not all survive the following winter. At the onset of cold weather, I had moved the animals to a terrarium 125 x 60 x 65 cm., with nearly constant daytime temperatures of about 77° F. and nighttime temperatures ranging from 59° to 64° F. A relative humidity of 40 per cent seemed to be most favorable for them. Yet, three of the four perished after a little over eight months in captivity.

In establishing my second community, I was fortunate in obtaining animals that had already lived for more than a year. Moreover, they were in such good condition that from the first

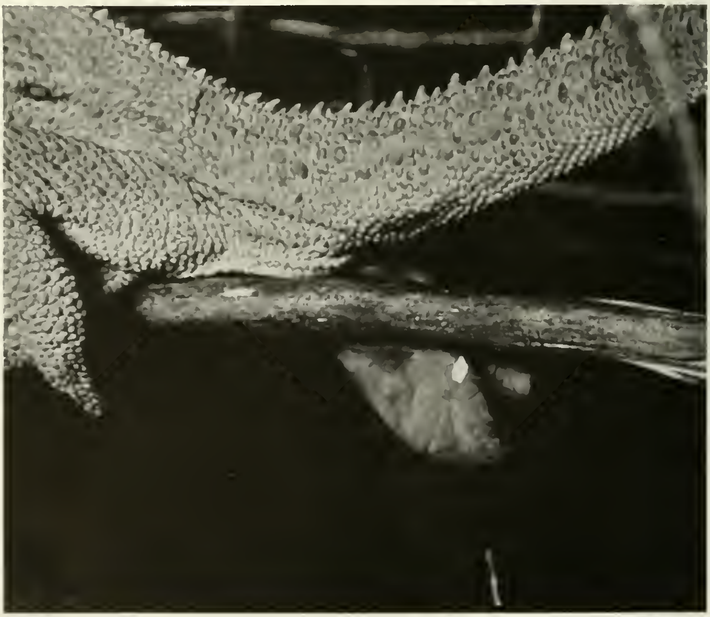
Normal coloring of the adult pygmy chameleon is shown here. At time of birth, animal's dominant hue is brown.



I expected better results than I had achieved before, especially in observations of their reproductive activity. Pregnant females are often imported. In most instances, however, they die before birth takes place, or shortly afterward. In captivity, the young usually are either born dead, or die very quickly. Unlike the females of most other species, which lay eggs, the pygmy female in its habitat gives birth to live young that are enclosed in a thin egg membrane as they leave the mother's cloaca.

Of the two females I acquired in a pregnant state for my second community, both gave birth to dead young. One of the mothers then died; the other recovered. I discovered that to keep a female alive following the birth of its young, large quantities of food must be provided at close range, for the animal is too weakened to hunt for prey. During pregnancy, with twelve to sixteen young developing in the female, she swells to such a point that it seems little or no space can be left

SAC EMERGES as a sticky bubble from mother's cloaca, *left*, and adheres to twig, *below*. Outline of the contracted young can be seen through membrane.

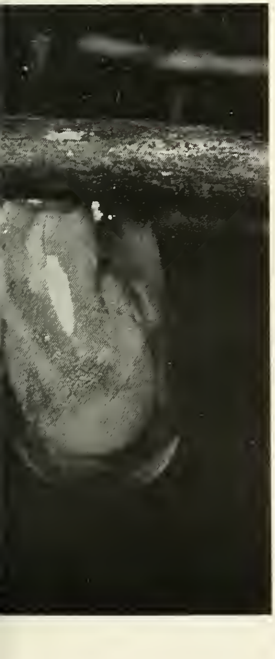


inside the body for the stomach contents and viscera. In this bloated condition, she probably nears starvation just before giving birth.

The female that lived after the birth of its fifteen dead offspring became the object of my next observations. I put her with another male two weeks after her pregnancy had concluded in the stillbirths. The male, which I had separated from the other chameleons for a considerable time, immediately moved toward the female as she reposed on a twig. There, on the twig, they copulated, the male on top of the female's back. I had observed attempts at copulation in pygmies before, but in those cases the female had been either pregnant or weakened, and the unions had not developed satisfactorily. Usually the females are passive during copulation—as was the one in this case—but they may on occasion attempt to fend off the male.

An interesting observation made several years ago is pertinent at this

A few seconds of inactivity, *below*, precede encased animal's struggle to escape, which it does at right. Note the umbilical cord visible below abdomen.



point. Apparently, a single mating sometimes insures the repeated production of viable young over many months without the need of subsequent matings. The scientific term "sperm storage" has been coined for this reproductive phenomenon. Many reptiles, particularly snakes and turtles, are known to store sperm—to the degree, indeed, that as long as four years after copulation young are produced by the female who, in the meantime, has had no access to a male.

Chameleons are the first lizards found to be capable of sperm storage. Three species are involved, one of which is our pygmy representative. In addition to being able to give birth to young as long as six months after fertilization (the normal developmental span is about three months), some of these chameleons carry embryos at different stages of development in the reproductive tract. This means that sometimes young resulting from the same fertilization will be born at different times, stretching over a period of about a month.

We are dealing then with two separate processes: one involves storage of the sperm, resulting in several separate ensuing fertilizations; the second involves differential rates of embryonic development from a single fertilization. Both phenomena lead to the production of young at frequent intervals without the necessity of an actual mating each time. In nature, such an ability might give the species that extra margin of reproductive potential that is essential for its survival.

With respect to the "social" aspects of mating, it is not known whether any one pair of pygmies stay together over long periods. It seems, however, that they do not. There is only a slight indication that some males become used to some females, and vice versa, or that such animals cease to threaten each other when they meet.

As pointed out previously, the females become extremely swollen during the time of pregnancy. The female that gave birth to fifteen dead young and then copulated two weeks later, clearly showed signs of pregnancy four weeks afterward. At the hind part of the female's body, the shape of the eggs could be discerned under the skin. Most of the time the female hung upside down from a twig and fed little. Whenever I put the male, which still lived in a separate terrarium, with this female, it would try to copulate with her but was fended off vigorously. The female opened its mouth, uttered puffing sounds, and shook the whole body from side to side. The male would then go away.

Two months later the pregnant female was so swollen that it could hardly move. Still, it caught two or three small grasshoppers or flies a day, although it had trouble swallowing them. Only by snakelike twisting of its head and body could the female press the food down through its throat and into its stomach. In another two weeks, it had stopped feeding altogether, as expected, and drank only a few drops of water each day.

Three months after the mating, I went into the room one morning and saw three pygmy chameleon offspring climbing among the twigs in the terrarium. In haste, I brought out my photographic equipment and set it up in front of the terrarium, for never before, to my knowledge, had pictures been made of actual chameleon birth. While I was still at work on the apparatus, another of the young was born. The mother lifted its tail, pressed the cloaca against the thin twig on which it sat, and the sac, with its translucent and very fine membrane, emerged. Inside I could see the young, which still was curled up, together with the yolk and the first excrement.

The sac adhered to the twig, and for a moment I thought the young was dead, for it did not move. Then after a few seconds it stretched its tiny body, tore the membrane, and the head emerged. With its forearms, it tried to take hold of the twig. As soon as it had managed to get a firm grip, it pulled the rest of its body out of the egg membrane, then began to climb the twig as smoothly as if it had already done so hundreds of times.

The mother had not changed position and paid no heed to the four offspring already born. Her respiration was heavy and I could see that the next throes had begun. By then I had readied the photographic apparatus, and started to make my first picture. Within the next hours, eleven more pygmies were born, three of them dead. The sacs did not always stick to the twig. Some dropped below to a lower twig or leaf, where they then adhered. Invariably the young started to move and struggle after a lapse of only several seconds. It seems clear that if the mother is weak, or is kept under inadequate conditions, her young will be weak at birth and thus unable to break out of the membrane. This is fatal, for at the time of birth they have already developed to a stage at which they will suffocate in a few minutes if they cannot escape.

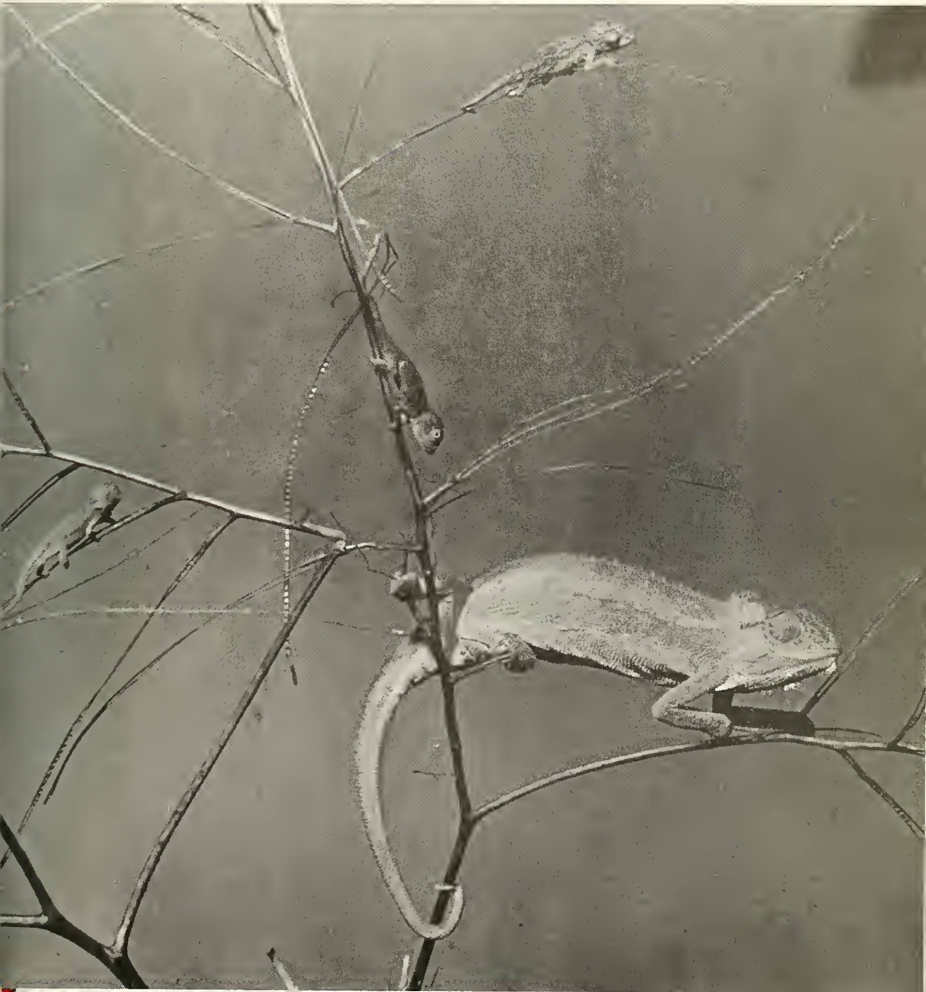
Altogether, fifteen young were born. Two days later the sixteenth and last

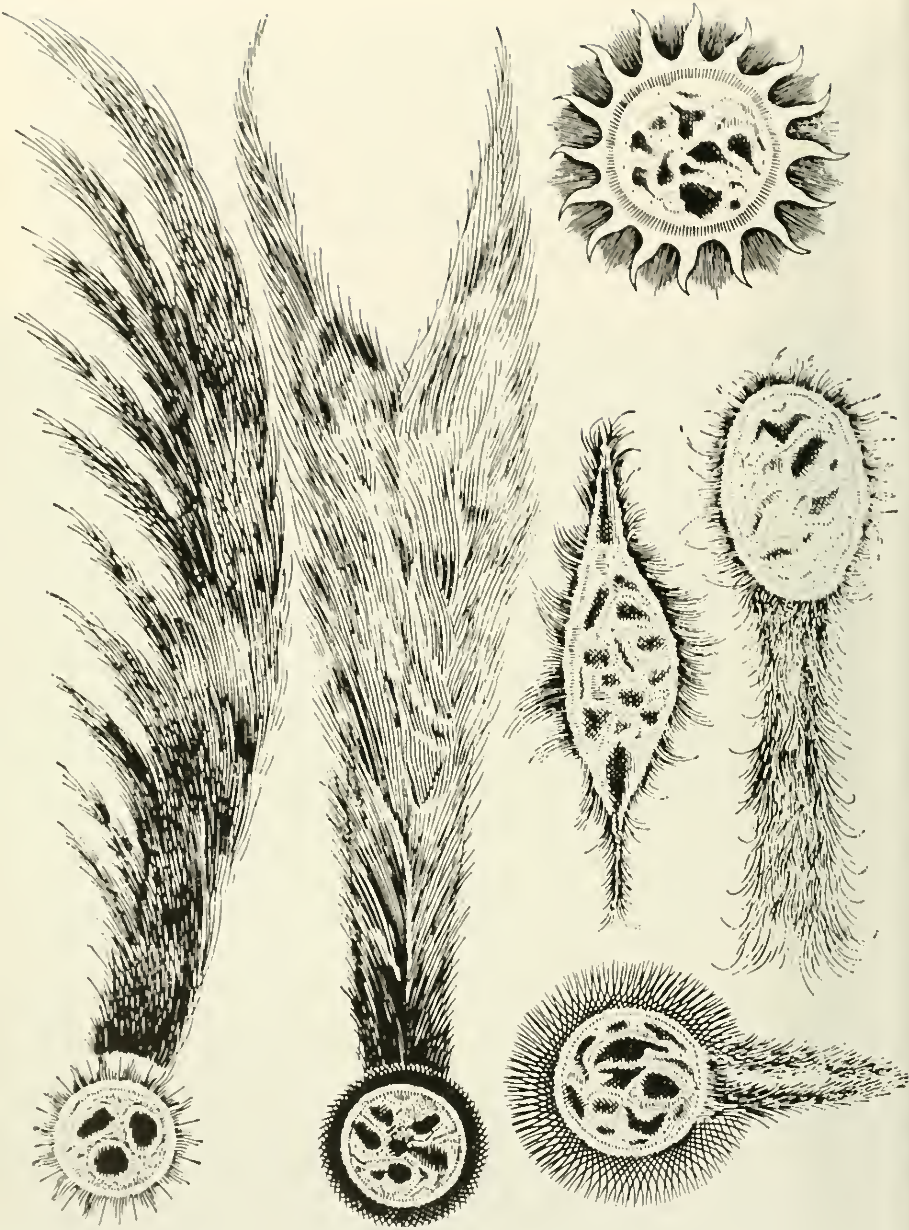
BROOD DISPERSES independently over the tree following emergence; mother remains in the throes of parturition.

was born dead. The mother began to eat immediately after the final birth, and recovered within several days. The young were removed to another terrarium with specially devised conditions, as they receive no care from the mother. In fact, adult pygmy chameleons may even feed on the newly born of their own species.

ALTHOUGH I had successfully fed adults, as foster parent to a group of 2 cm. chameleons I encountered special problems. The food easiest to provide is *Drosophila*, tiny fruit flies that can be cultivated without difficulty in glasses, using bananas or other fruits. The young start to lick water drops from the twigs immediately and begin to feed one day after birth, but, as was noted earlier, do not at once hit the prey accurately. After about one week of life, the progeny show the same threatening behavior that adult pygmy chameleons display toward other individuals—flattening the body, opening the mouth, and uttering puffing sounds.

The first shedding of skin by the offspring occurred about three weeks after birth. The old skin came off in large pieces, and the whole process took one or two days. Chameleons in an unhealthy condition need much more time to complete this process. As soon as the young had reached a length of 4 to 5 cm., I began to feed them larger insects, for to maintain their health, the proffered food must be varied. Three of these young died during their first weeks. However, the others and the mother all survived.





SKY REPORTER

Comets' wanderings end eventually in dissipation into space

By Simone Daro Gossner

The well-ordered arrangement of planets around the sun is little more than the skeleton of the solar system. Between and beyond those large bodies are countless chunks and conglomerates of matter—asteroids, meteorites, mere dust, and, of course, the comets.

The seemingly haphazard motion of the latter and their unheralded appearances had much to do, no doubt, with their having generally been considered ill omens in medieval times, when they were thought to be mysterious emanations of the atmosphere—meteorological occurrences rather than astronomical bodies. Since there were no telescopes in those days, only the brighter comets were noticed. Thus, to early observers, cometary appearances seemed less frequent than they really are.

In 1577, the great Danish astronomer Tycho Brahe noted that a certain comet had been sighted simultaneously from Prague and from Denmark. Reasoning that an atmospheric event could not be seen from such widely separated places, he deduced correctly that the comet had been even farther from earth than is the moon. He plotted its path and decided it was in orbit around the sun. For the first time in the history of astronomy, comets were recognized as true members of the solar system.

In the following century, astronomers were much interested in the bizarre comet shapes revealed by the newly invented telescope. Straining at the limit of vision, they tried to draw what they observed *(shown at left)* and described what they saw in fanciful terms. Nothing was known of the composition of comets until their light was analyzed with the spectroscope, within the last century. Even now, their exact structure is a matter of speculation.

Comets travel in extremely elongated orbits that carry them well beyond the distance of Pluto. With modern telescopes they are usually spotted while they are still at some distance from the sun. At that time, they have an almost starlike appearance, except that they are somewhat blurred around the edges. As a comet approaches the sun, its starlike nucleus becomes surrounded by a diffuse cloud of nebulosity called the *coma* (Latin for hair), the over-all brightness increases, and, in most cases, the comet grows a tail. The coma may be thousands of miles in diameter, and comet tails have been known to span as much as 100 million miles. The nucleus, on the other hand, seldom exceeds a few tens of miles. These metamorphoses are among our best clues to the nature of comets.

For all their size, these wanderers of the solar system have been aptly described as "bags full of nothing." Their mass is less than one-billionth that of the earth, and most of it resides in the nucleus. The latter is solid only because the chunks of rocky matter that compose it are embedded in water ice and frozen gases—methane, ammonia, carbon dioxide, and cyanogen. As the comet nears the sun, its outer layers of ice melt, causing the gases to escape. The gases, in turn, carry along some of the finer solid particles and this mixture forms the coma.

The development of the tail results from the combination of two separate forces, both of solar origin: radiation pressure and solar wind. The former is the repulsive force exerted by a strong beam of light. For minute comet particles at short distances from the sun, radiation pressure is strong enough to repel the particles. The recently coined expression "solar wind" designates the stream of high-speed hydrogen nuclei (also called protons) and other atomic fragments that constantly emanate from the sun. The impact of their collisions with tenuous cometary material is sufficient, once again, to drive it away.

Unfortunately for a comet's future, all matter that goes to form the coma and the tail eventually dissipates into space and is irretrievably lost. Since the same process takes place every time the comet returns to the sun's vicinity, sooner or later there is not enough substance left in the comet's nucleus to hold it together by gravitation. The remnants scatter along the comet's orbit. If, perchance, the earth intersects that orbit, a meteor shower may occur as our atmosphere sweeps up the debris.

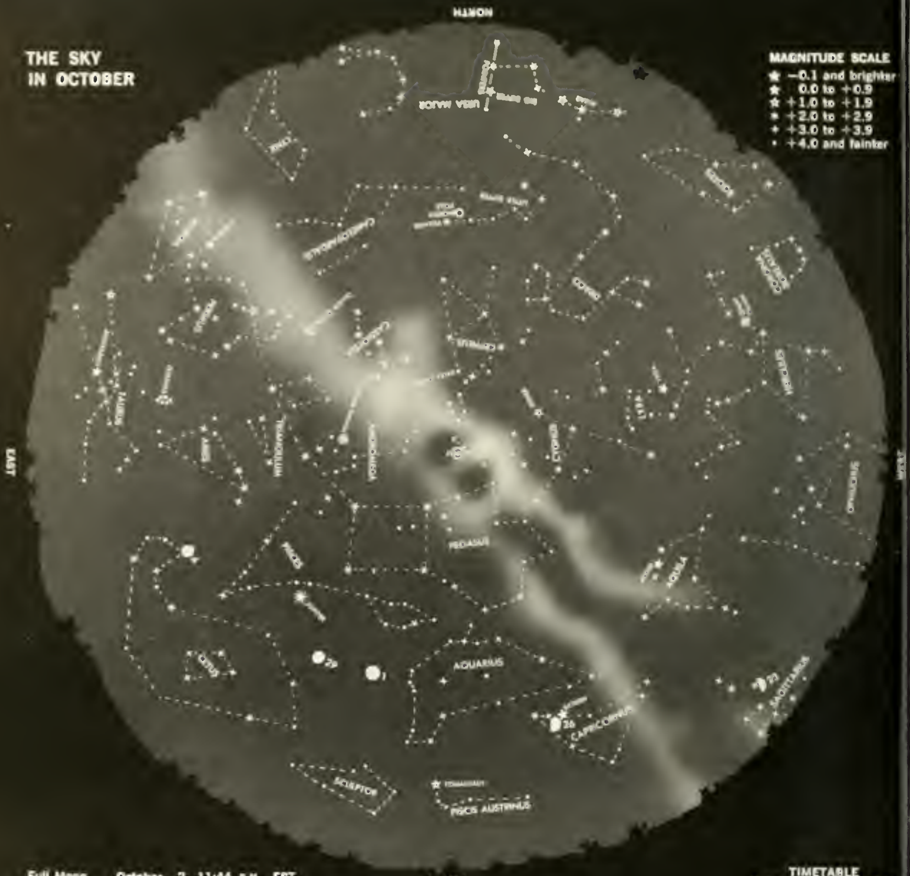
It has been estimated that a comet can survive at most a few hundred returns to the sun's vicinity. If they were formed several billion years ago with the rest of the solar system, how can one explain that they have not all been disrupted by now? Several theories have been proposed in the past, and it was thought at one time that comets are occasional visitors from interstellar space rather than members of the sun's retinue. If this were true, however, their trajectories would be open curves—hyperbolas or parabolas—instead of ellipses. Although many comets have nearly parabolic orbits, the majority follow decidedly elliptical paths. All observational evidence weighs heavily in favor of their belonging to the solar system.

The currently accepted theory of the origin of comets was proposed by the Dutch astronomer Jan Oort several years ago. He suggested that a vast cloud of comets surrounds the solar system beyond the orbit of Pluto and extends some 14 trillion miles into space (about halfway to the nearest star). The total comet population in the cloud is estimated at 100 billion. All except a few remain at an enormous distance and are never visible. But occasionally the gravitational effect of nearby stars deflects one of the comets into an orbit that carries it close to the sun.

What happens next depends on the circumstances of this fateful journey. If the comet's path stays clear of the most massive planets, it may simply go around the sun in a highly elongated orbit and return to the cloud, never to repeat the journey. If, however, it passes in the vicinity of Jupiter or Saturn, the perturbations caused by these giants may suffice to deflect the comet into a shorter orbit. It will then return periodically and will undergo gradual destruction. The most famous periodic comet of all is Halley's, which has been seen at every return except one since 240 B.C. Its next appearance is expected in 1986.

On these pages Mrs. Gossner presents the eighth in her 1963 series—a co-ordinated review of the solar system.

THE SKY IN OCTOBER



Full Moon	October 2, 11:44 P.M., EST	
Last Quarter	October 9, 2:27 P.M., EST	
New Moon	October 17, 7:43 A.M., EST	
First Quarter	October 25, 12:20 A.M., EST	

TIMETABLE

October 1	10:00 P.M.
October 15	9:00 P.M.
October 31	8:00 P.M.

(Local Standard Time)

Mercury, in the morning sky, will be at its greatest western elongation on October 5. It should be clearly visible in the east for the first three weeks of the month, rising one hour before the sun on October 1, and ninety minutes before on October 15. Its magnitude will brighten from +0.1 on October 1 to −0.8 on October 15.

Venus (−3.4 magnitude), in the evening sky, will be very low above the western horizon and hard to see throughout the month. It will set soon after the sun all month long.

Mars (+1.6 magnitude) will also be too close to the horizon for good viewing during October. Mars will be in the southwest at sunset and will set about ninety minutes later.

Jupiter (−2.5 magnitude), in Pisces, will rise at sunset October 1 and will be visible all night. By mid-month it will be in the eastern sky at sunset and will set one hour before sunrise October 15, and two hours before on October 31.

Saturn (+0.8 magnitude), in Capricornus, will be in the southeastern sky at dusk. It will cross the meridian, low in the south, at about 8:00 P.M., local standard time, and will set in the southwest at approximately 1:45 A.M. on October 1, at 1:00 A.M. on October 15, and at 12:15 A.M. on October 31.

The Orionid meteor shower is expected October 20. The moon will be three days old on that date and should not interfere with observations. This shower averages twenty-five meteors per hour at maximum (as seen by a single observer).

Orionids are caused by the debris of Halley's comet. After multiple passages near the sun, innumerable dust particles and small meteoric fragments become detached from the main body of the comet. Since the particles and fragments are all at approximately the same distance from the sun, they travel around it in nearly identical orbits similar to the orbit of Halley's comet itself. But, in accordance with Kepler's laws of planetary motions, the slight differences in the particles' distances from the sun cause them to travel at somewhat different speeds. Over the years the particles have become scattered along the entire orbit of the comet and are no longer concentrated in its vicinity.

Twice a year, in May and in October, the earth approaches very near the orbit of Halley's comet. The resulting meteor showers are known as the Eta Aquarids, which attain their maximum on May 4, and the Orionids, which are visible this month. Both showers have approximately the same intensity.

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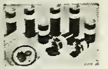

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Do a crystalography project illustrated with large beautiful crystals you grow yourself. Kit includes the book "Crystals and Crystal Growing" and a generous supply of the chemicals you need to grow large display crystals of potassium aluminum sulfate (clear), potassium sulfate (purple), potassium sodium tartrate (clear), nickel sulfate hexahydrate (blue green) or heptahydrate (green), potassium ferricyanide (red), and copper acetate (blue green).

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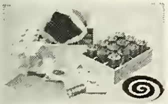

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Terrific Buy! American Made!

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Projects illustrations up to 3" x 3½" and enlarges them to 35" x 30" if screen is 6½ ft. from projector; larger pictures if screen is further away. No film or negatives needed. Projects charts, diagrams, pictures, photos, lettering in full color or black-and-white. Operates on 115 volt, A.C. current. 6-ft. extension cord and plug included. Operates on 60 watt bulb, not included. Size 12" x 8" x 4½" wide. Weight 1 lb., 2 oz. Plastic case with built-in handle

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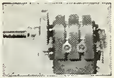

Brand new Signal Corps Electric Generator for scientific experiments, electrical uses, demonstrations. Generates up to 90 volts by turning crank. Use in high impedance relays. Charge ground and bring up night crawlers for bait or study. 2 Alnico Magnets alone worth original price. Wt. 2 lbs Cost to Govt. $15.

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Same type generator, mounted, with light, as electricity demonstrator.

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With this Kit, you can collect fluorescent rocks, paint with living light, write secret messages, learn invisible detection methods, even make a fluorescent Christmas tree! Kit uses longwave blacklight, which is completely harmless to eyes, but causes fluorescence in over 3,000 substances. Includes Magic Glow Lamp, universal laboratory lamp stand, invisible water paints and ink, fluorescent crayon, tracer powder, pen, 3 brushes, specimens of fluorescent rocks: wernerite from Canada, fluorite from England, willemite from U.S.A. Plus book of 40 experiments

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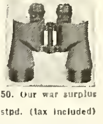
7x50 BINOCULARS



Big saving! Brand new! Crystal clear viewing — 7 power. Every optical element is coated. An excellent night glass — the size recommended for satellite viewing. Individual eye focus. Exit pupil 7 mm. Approx. field at 1,000 yds. is 376 ft. Carrying case included. American 7 x 50's normally cost $274.50. Our war surplus price saves you real money

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7 x 35 American made binoculars

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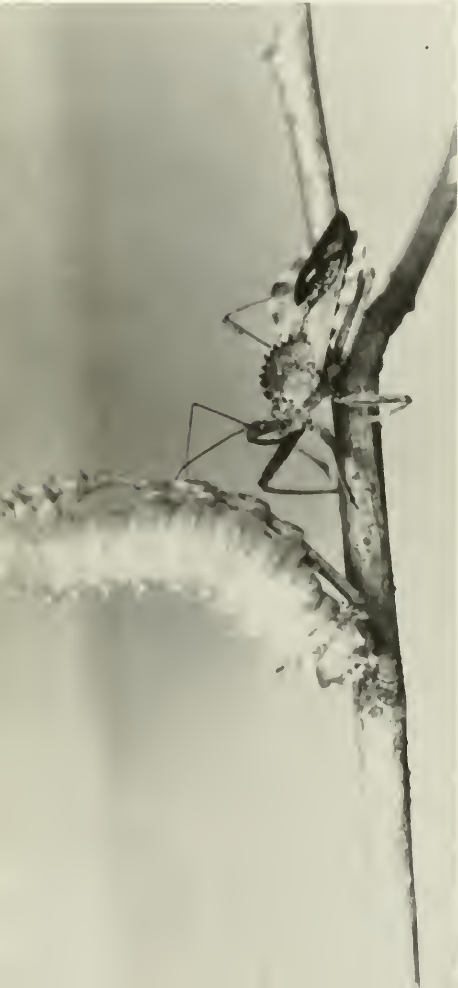
Naturalists' Notebook

PROWESS OF A WHEEL BUG

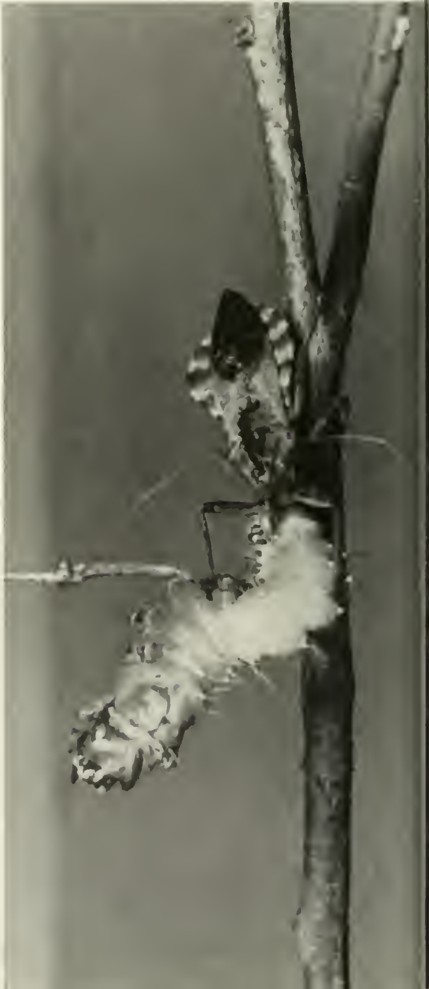
Insect assassin takes huge prey

THE WHEEL BUG (*Arilus cristatus*), pictured in a unusually bold act of predation, is a very larg member of the family Reduviidae, which is of worl wide distribution, and includes nearly four thousan species. Members of the family vary in size from ex tremely small to well over an inch in length, but a are distinguished by possessing powerful beak through which they suck the blood of other insect and of larger animals, including man. Because the usually kill their insect victims, they have gained th distinctive common family name of assassin bug

AT 6:00 P.M., the wheel bug, shown at about life-size, approaches the larva.

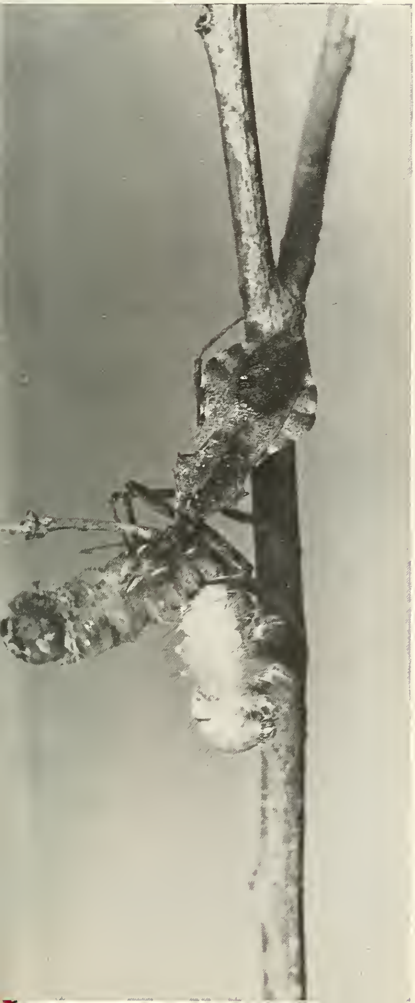


AT 6:10 P.M., predator punctures the writhing larva with its powerful beak.

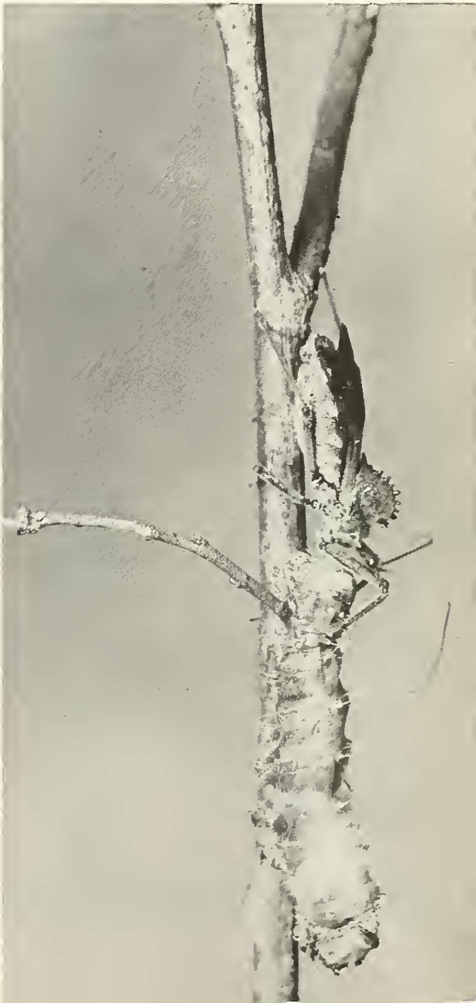


Ordinarily, even the giant wheel bug will not at- k prey the size of the polyphemus moth larva own below. This series of laboratory pictures monstrates, however, that it has been done. To ke these observations, the wheel bug was placed the stem of a small tree near the resting place the larva, and after what appeared to be a brief riod of orientation by means of its antennae, it emed ready to deliver a lethal stab with its beak. t at this moment, the caterpillar began to crawl. The wheel bug blocked the larva's path and struck. Pierced by the barb, the larva writhed back and forth in an attempt to free itself. The wheel bug, only one-tenth the weight of the larva, clung fast and made the kill with the aid of a salivary fluid that prevents coagulation of a victim's body juices. Then, holding the dead larva around the mid-section, it began to feed by boring into the soft parts. When the predator finally released a much deflated polyphemus, it cleaned itself of remnants of the meal by rubbing its legs over its head. In this country, the wheel bug is found chiefly in the southern states.

At 6:30 p.m., the caterpillar is dead and wheel bug bores into body to feed.



By 7:00 p.m., the satiated predator is ready to drop the blood-drained body.



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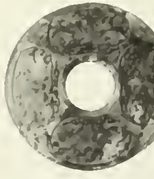
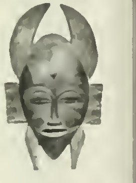
NH 102—Wooden Cup. Original carved by Lele tribe of Kasai River in Central Congo. 6" high. $7.75 postpaid.

NH 70—Buddha of Infinite Light. Made in China. 10½" high. $27.50. Shipping charges additional.



NH 34—Symbol of Heaven. Chinese, 18th or 19th century. 13" diameter. $27.50. Shipping charges additional.



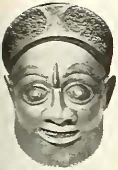
NH 104—Horned Mask. Se
tribe, Ivory Coast, Africa. 1
high. $15.50. Shipping cha
additional.

NH 65—Peruvian Llama. Inca, 15th or 16th century. 2" high. Stand—$3.00 postpaid. Pin—$3.25 ppd. tax incl.

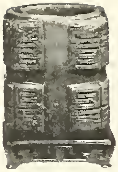
NH 67—Effigy Vessel. Plumbate pottery from Guatemala. Toltec, A.D. 900-1200. 7¾" high. $13.75 postpaid.

NH 66—Smiling Head. Vera Cruz, Mexico. About A.D. 1000. 12½" high. $15.00. Shipping charges additional.

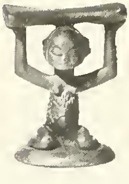
NH 101 — BaTeke Figure. Fr
Equatorial Africa. 14¾"
$16.50. Shipping charges
tional.



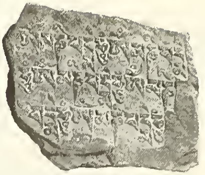
)6—Laughing Mask. From
an in the Cameroons, Africa.
;h. $19.65 postpaid.



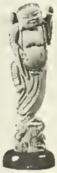
NH 33—Dragon Vase. Han Dynasty (202 B.C.-220 A.D.). 6½" high with base. $16.25 postpaid.



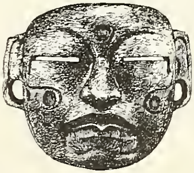
NH 107—Headrest. From the Lualaba region, Central Congo, Africa. 7½" high. $13.25 postpaid.



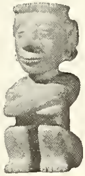
NH 75—Prayer Plaque. Tibetan. 18½" x 15¼". $17.50. Shipping charges additional.



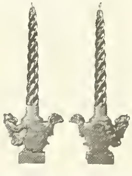
–Liu Hai and Toad. Chinese,
:entury. 7½" high. $13.00
id.



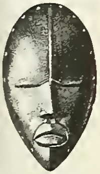
NH 68—Olmec Mask. Guerro, Mexico. A.D. 300-600. 7¼" high. $13.50 postpaid.



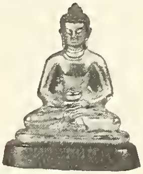
NH 61—Mexican Figurine. Probably Mixtec, 15th century. 2⅝" high. $4.00 postpaid.



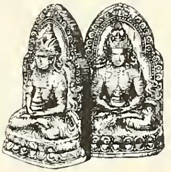
NH 5—Candle holders. Tlingit Indian, Alaska. 4" high. $13.50 pr. postpaid.



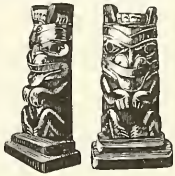
5—Dance Mask. From Ivory
Africa. 9" high. Original
in wood. $8.50 postpaid.



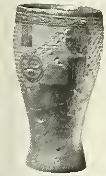
NH 71—Lamaist Buddha. Tibetan. Probably 19th century. 6" high. $10.75 postpaid.



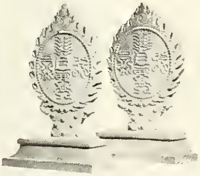
NH 76—God of Infinite Life Book ends. Tibetan. 5" high. $13.00 pr. postpaid.



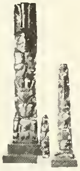
NH 4—Totem Book ends. Haida Indian. Probably late 19th century. $13.75 postpaid.



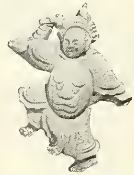
)3 — Bakuba Cup. Wooden
ıold utensil of Bakuba tribe,
. Africa. 7½" high. $10.75
id.



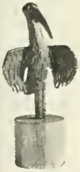
NH 74—Symbol of Buddhist Law. Book ends. Japanese, 19th century. 8½" high. $13.50 pr. postpaid.



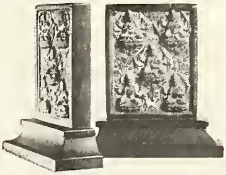
Totem Poles — NH 1 — 6" high, $4.50, ppd., **NH 2**—11" high, $8.00 ppd., **NH 3** — 18" high, $12.75. Shipping charges additional.



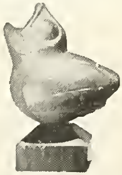
NH 32—Court Dancer. Chinese, Ming Dynasty (1368-1644). Worn as pin or pendant. 3" high. $3.50 ppd., tax incl.



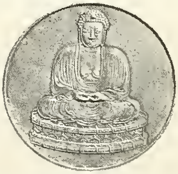
08—Ibis. Original cast in
by the Benin tribe, South-
;eria, Africa. 8" high. $18.00
id.



NH 73—Tibetan Book ends. Original is carved sandalwood. 6½" high. $19.50 postpaid.



NH 6—Raven. Stone pipe, Tlingit Indian, Northwest Coast of Alaska. 3" high. $6.00 postpaid.



NH 77—Magic Mirror. Japanese. 6¾" diameter. Has a bronze-like finish. $5.50 postpaid.

Photos: Lyman Nichols

Exakta with 50mm lens

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About the Authors

Dr. Kenneth L. Franklin, Associate Astronomer at The American Museum-Hayden Planetarium, discusses the much misunderstood subject of gravitation and the forces that keep planets in their orbits in a two-part article that begins in this issue. Among Dr. Franklin's keenest astronomical interests are binary stars, galactic structure, and radio astronomy. The illustrations for his article were prepared by Mr. Helmut Wimmer, staff artist at the Planetarium.

Techniques and aims of scientific research in the Arctic and Antarctic are reviewed in "Secrets from Cold Storage," by Mr. William J. Cromie, who has had firsthand experience in both regions. Mr. Cromie worked as a geologist for a mining company, spent fourteen months at Little America, was chief mate and oceanographer aboard the research schooner *Vema*, served as chief scientist for Columbia University's scientific group on Arctic Ocean Drifting Station Charlie, and until recently held a post with the Mohole Project. Mr. Cromie has written many articles in the field of science, and he is the author of a number of books and scientific papers.

The description and unusual photographs of the pink-headed warbler are the work of Mr. Walter Dawn. A professional photographer of nature subjects, Mr. Dawn is widely known for his photographs of birds.

Dr. E. Yale Dawson, who explains the "Ecological Paradox of Coastal Peru," is Professor of Biology at the University of Southern California and is also with the Allan Hancock Foundation. He is a phycologist, and has written previously for this magazine. He spent the summer in research at the University of Washington's Friday Harbor Marine Laboratory, which is situated on San Juan Island, Washington.

A vertebrate paleontologist, Dr. John Clark is on the staff of the Chicago Natural History Museum. His observations of Hunza, a Himalayan protectorate of Pakistan, derive from two sojourns in the little-known kingdom during which he engaged in geological research and operated a dispensary.

Dr. Otto von Frisch, author of "Enigmatic Lizard," is assistant in mammals, birds, and reptiles at the Museum of Natural History in Braunschweig, West Germany. He is currently investigating the behavior of reptiles and amphibians. Dr. von Frisch made the photographs that accompany his article, and he believes that they are the first such photographs to have been taken.

Karl
von
Frisch

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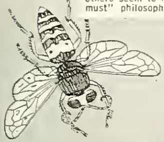

WASPS WALKING ON WATER? Some spider-catching wasps do drag their prey home over water; others seem to have a "dig we must" philosophy.

Sioux and space station... wasp and dodo...

MAN'S FIRST MOON COLONY? But will it be armed fortress, scientific laboratory, or — as is conceivable — a booming mining town?

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PHOTOGRAPHIC PRODUCTS

NATURE and the CAMERA

Color photography in theory and practice

By David Linton

Color reproduction in photography is not totally accurate, but the photographer should regard this as a spur to his creative efforts. The photograph is an entity a beautiful one, we hope and *not* merely a reproduction of nature.

A very important reason why colors cannot be reproduced "accurately" is that our color perception is variable. The appearance of a color is influenced by its surroundings, the light falling on it, and by what we "know" about it.

Another phenomenon of color vision is the ability of the eye to resist changes in the color of objects caused by changing illumination. The most common illustration of this is provided by the shifting colors of daylight. A white sand beach will still look white in the late afternoon, although the light illuminating it is actually orange; it will also look white on a cloudy day when the light is rich in blue. This effect, known to psychologists as "constancy," is produced entirely in the visual cortex of the viewer, and it cannot be duplicated by the film in a camera.

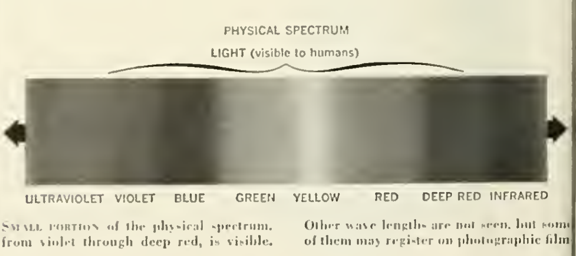
Color and Light Sources

Every type of color film is "balanced" for one specific kind of light. "Daylight" films are balanced for a mixture of direct sun and reflected skylight that occurs at midday in temperate latitudes. The "indoor" films are balanced for one or another of the most commonly used artificial light sources. Since films cannot correct themselves as does the eye, the photographer must correct them for any illumination that differs from that for which they were designed.

"White" daylight is actually a mixture of colors, including the entire visible spectrum plus a bit of ultraviolet at on extreme and some infrared at the othe The proportions change with weathe and time of day but the complete rang is there Incandescent lamps and flas bulbs are similar in that they have *continuous spectra* the range of colors i the light may not be as wide as in day light, but within the existing range al colors that belong in that part of th spectrum are represented.

The apparent color of the light fron such sources is measured in terms o "color temperature" the actual temper ature (in degrees Kelvin) to which standard "black body" must be heate to give off light of the same apparen color It must be emphasized, however that color temperature describes onl the *apparent* color of the light: how i looks. But apparent color does not defin the actual composition of the light. Tw light sources may look the same eve though their light is made up of differen components. The same is true of color

Some light sources, such as fluorescen lamps, have discontinuous spectra som wave lengths are not represented in thei output. Objects look reasonably natura to us under these lights because the ey is somehow able to compensate for th missing colors. Film, of course, has n such capacity to adapt. Color photog raphy with these light sources is unpre dictable, but such lighting can be quit useful if tests can be made and evalu ated in advance. One advantage of fluo rescent lights is that they produce ver little heat (infrared is not included i their spectra). Another advantage i that fluorescent tubes can be made i various shapes, including that of doughnut, so the light source can sur round the lens (or the subject, if it i



Small portion of the physical spectrum, from violet through deep red, is visible. Other wave lengths are not seen, but som of them may register on photographic film

PEOPLE OF THE FOREST

y Hans Lidman

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small) to produce shadowless illumination. Color temperatures cannot be used to describe the light such sources emit.

Extreme examples of discontinuous spectrum light sources emit only one or a few narrow bands of wave lengths. Mercury-vapor and sodium-vapor lamps used for illuminating highways are the commonest representatives of these extremes. The distribution of wave lengths in their output is so meager that not even the human eye can perceive colors under them. They are not suitable for color photography.

Filters Provide Control

Color rendition is controlled by the color of the light and by filters. Filters are generally placed in front of a lens, although for some special purposes they are used over the light sources. In a few long lenses filters are inserted between or behind the optical elements of the lenses.

Filters absorb, or "block," certain wave lengths of light and transmit others. A filter may transmit a wide band of wave lengths or a narrow one, and the boundary between the absorbed and transmitted wave lengths may be gradual or abrupt. It is impossible to tell from the filter's appearance. For example, a "red" filter is one that appears red to the eye. It transmits red light and absorbs light of other colors to a greater or lesser degree. All filters that look red are red filters, but their optical characteristics may differ in ways that cannot be distinguished by the eye.

The action of filters is essentially the same with color as with black-and-white films, since all films operate on the same principle. But heavily colored filters cannot be used with color films because they impart an over-all cast to the picture. The great control possible in black and white through the use of filters cannot be matched in color.

A convenient example is the problem of photographing a distant landscape through haze. Some haze is always present, the amount varying with the location and the weather. The extent to which it appears in a picture can be, and is, controlled with filters.

Effects of Scattered Light

Haze is composed of minute particles of moisture and dust in the atmosphere that scatter some of the light coming from the sun, diverting it from its path. The scattering is selective; it is greatest at the blue end of the spectrum and least at the red end. Scattering is similar to the breaking up of "white" light into spectral colors, as is done by the drops of water that form a rainbow. A similar phenomenon occurs in snow, where ice crystals scatter light in some-

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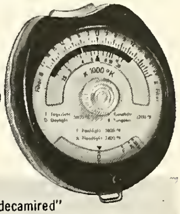

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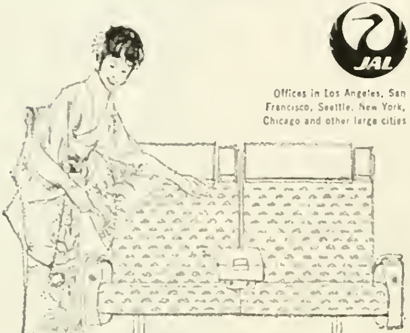

what the same way. The light passin
through snow becomes predominant
blue. The light inside snow caves *(se
cover photograph)* is blue and so are th
shadows that reveal texture in masses o
snow. The texture will be lost unless
filter is used to block some of the intens
blue light and most of the ultraviole
that otherwise light up the shadows an
make them look the same as the high
lights to the film.

Scattering accounts for the blue ap
pearance of the sky and also for the re
color of the setting sun. The ultraviole
violet, and blue are scattered the most a
they pass through the atmosphere. The
are reflected down toward the earth, th
imparting their colors to the sky, esp
cially that part of the sky opposite th
sun. It is as though the sky were a gian
mirror that can reflect only blue ligh
Looking at it we would see it as blu
The orange, red, and infrared pa
through the atmosphere with much le
scattering. Consequently they are n
seen in the part of the sky that is illum
nated only by scattered light (they pa
through the mirror).

When we look at the sun we see a
the colors, because all pass through th
atmosphere, but some of the blue is r
moved before the light reaches us. Whe
the sun is low in the sky, however, it
seen through a much greater thickne

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f atmosphere than when it is overhead.
he thickness is so great near the hori-
on that not only the blue rays but also
nuch of the green and yellow are scat-
red before they reach us. and all that
emain are the orange and red parts of
ne spectrum. That is why the setting
in looks red. The missing blue rays.
neanwhile. are reflected down on the
arth as "skylight" farther around the
arth's circumference. where it is still
ay *(diagram page 70, bottom)*.
What we define as "white." or "color-
ss," light is highly variable. ranging
ll the way from the light of a kerosene
mp to that of a carbon arc. "White"
inlight as we know it is sunlight that
as had much of the blue filtered out of
by passing through our atmosphere.

Subduing Atmospheric Haze

DISTANT scenes on earth have a
"washed-out" appearance because
ne atmosphere through which they are
en and photographed scatters blue
ght and ultraviolet like a smoke screen.
he light that is scattered *in front* of the
bject obscures our view *(diagram page*
9, top). The effect is more apparent
n film than it is to the eye because the
lm is sensitive to ultraviolet but the
uman eye is not. Ultraviolet is scattered
ven more than blue light. In black and

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white it appears as extra light and reduced contrast. Color film records it as a washed-out, bluish haze.

As we have seen, red and orange wave lengths of light penetrate the atmosphere with less difficulty than blue ones. Therefore, if we are to photograph a distant scene, we would expect to achieve increased clarity by restricting the response of the film to the reddish wave lengths. This is what happens in actual practice. It is not always desirable, however, to eliminate haze completely since it is one of the cues that enable us to "see" depth. We are accustomed to the progressive "graying" of colors and softening of contrasts as distance increases (called "atmospheric perspective" in painting). People arriving for the first time in the mountains, where the air is extremely clear, consistently underestimate distances.

With black-and-white film, we have almost complete control over the amount of haze visible in a photograph. We can *increase* the apparent haze by using only the blue end of the spectrum, taking the picture through a blue filter. This reduces the effect of other colors and accentuates the scattered wave lengths.

With no filter, the haze would still be heavier in the picture than it looks to the eye, because of differences in sensitivity between eye and film.

The scene could be shown approximately as it appears to the eye by photographing it through a medium yellow (K 2) filter. For greater haze penetration, an orange filter could be used. Next, with panchromatic black-and-white film (the only type in general use now) a red filter could be used, then a darker red.

Finally, for absolute clarity, we could change to infrared-sensitive film and a filter that excludes virtually all visible light, thus exposing the film only to infrared, which is not scattered by the atmosphere. (This technique is used in aerial photography, and it permits photographing through clouds.)

With each step the exposure must be increased because less of the total light is being used. Also, with each step the sky becomes darker as a greater proportion of the blue skylight is prevented from reaching the film. There are other changes, too, making the picture look progressively less natural. In the final case, using only infrared, foliage appears white and the sky black.

As a rule, any filter will lighten objects of its own color and darken those of a complementary color. In addition to the blue, yellow, orange, and red filters just described, there are a few more-specialized types used with black-and-white film. One of the most useful is a light green, which can make foliage appear lighter and darken the sky without lightening skin tones when people are photographed outdoors.

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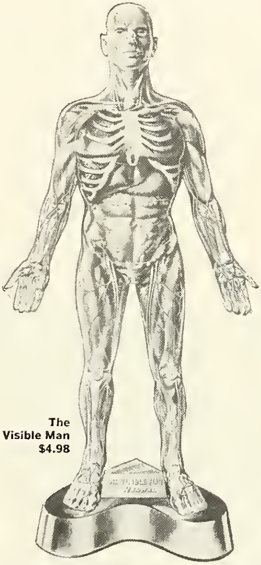

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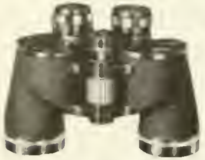

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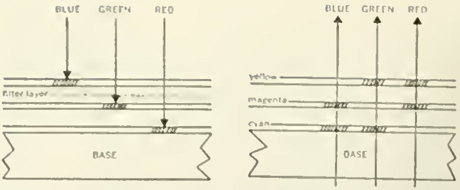

COLORS IN SCENE register as combinations of exposures in color film emulsion layers (*left*). Yellow filter layer shields lower emulsions from blue light and dissolves in processing, during which the unexposed emulsion areas absorb dyes complementary to their primaries. Light passed through these dyes in a transparency approximates original colors (*center*). Wheel shows how primary colors combine in photography.

Filters for Color Films

In color photography, the control that filters provide is more limited because filtering can throw the color off balance quite obtrusively.

With no filter, the color film, like the black and white, will record more haze than the eye can see because of the film's sensitivity to ultraviolet. We can correct the sensitivity of the film to approximate that of the eye by blocking the ultraviolet with a "Skylight," "Haze," or "UV" filter. Since most of the wave lengths they block are invisible to us, these filters appear almost colorless. They do not ordinarily require any increase in exposure.

An orange filter would give greater haze penetration, as it does in black and white, but it would color the entire scene orange. The solution is to use a film balanced for a warmer (more orange) light with the appropriate orange conversion, or light-balancing, filter to adapt it for daylight use. When this is done, a reduced exposure index, stated in the data sheet packed with the film, must be used. Conversion filters are made for each type of "indoor" film. It is not

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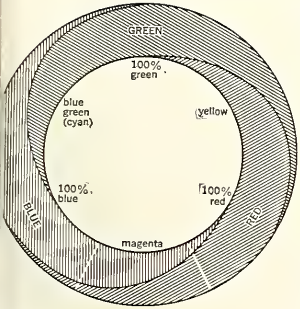

generally known, however, that these filters also subdue haze. Of course, they are not as dark as the filters used with black and white. The filters used in color photography do not block *all* of a color, they merely absorb some of it to correct the balance among the colors. Although it is convenient to say that a filter of a given color adds its color to the light passing through, it actually works by subtracting other colors from the light.

Color films record their images in black and white. The actual physical difference between color film and black-and-white film is that color film has three emulsion layers "stacked" on one base, whereas black-and-white film ordinarily has one emulsion layer. Each of the three emulsion layers in a color film records a different portion of the spectrum.

Three layers are used because all colors can be approximated by various mixtures of three properly selected primary colors. In photography the primary colors selected are blue, green, and red. Various proportions of these colors produce not only all the colors of the spectrum—from deep red to deep violet—but also those colors that do not occur in the spectrum but are nonetheless visible. The non-spectral colors appear to be between blue and violet—the purples and magentas. If the spectrum thrown by a prism is bent into an incomplete circle with these colors filling the gap between the red and blue ends, any two colors opposite each other will be complementary—if mixed, they will produce neutral gray. Reproduction of colors in color photography can be best understood if the colors are represented by such a circular graph. To describe colors completely requires two more dimensions—one representing the purity, or saturation, of the color, and the other how "light" or "dark" it is. All these qualities are represented by various

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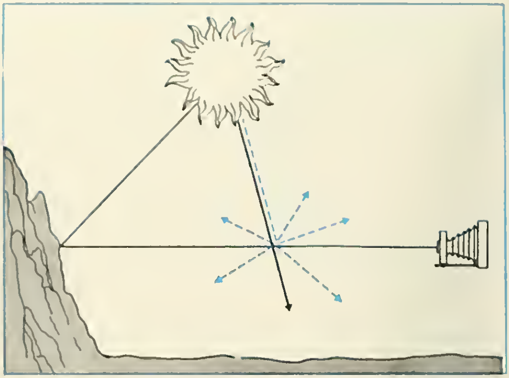


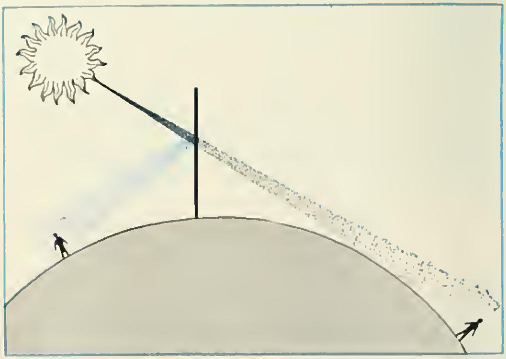
ATMOSPHERE scatters blue and ultraviolet wave lengths, giving "washed-out" look to photographs of distant scenes. The effect may be controlled through use of filters.

combinations of exposures in the three layers of a color film.

It is easy to see that if we want to decrease the exposure in one layer of a color film the way to do it is to use a filter that will block light of the color to which that layer is sensitive. If we want to increase the exposure in that layer, a filter can do it only by blocking the colors of light to which the other two layers are sensitive. For this reason there are two types of filters for each layer in the color film. They are negative—those that reduce the exposure in the layer—and positive—those that increase the *relative* exposure in the layer. The negative filters are cyan, magenta, and yellow; the positive are red, blue, and green. Each color is available in seven densities, or degrees of darkness.

In addition to these basic filters, there are several special ones. For specific situations they provide all necessary corrections for all three emulsion layers in one filter, eliminating the need for a "pack" of filters and reducing the loss of light that occurs when several filters are used together. Special-purpose filters include conversion filters and filters that produce an over-all "warming" or "cooling" effect to correct daylight films for conditions of illumination other than noon sunlight on a clear day.

With color negative film, corrections can be effected when making the positive print or transparency. This is usually more convenient than making corrections at the camera when the film is exposed. For this reason, negative color films are not made to match a variety of different light sources. The degree of control available is one of the advantages of this type of film. Among the other advantages are the possibility of making color transparencies, color prints, black-and-white prints, or printing plates all



BLUE SKY seen by man at left is colored by blue light atmosphere scatters. Setting sun looks red to man at right because red and orange light is relatively unaffected.

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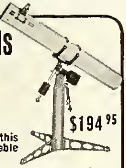

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from the same negative, and the ease with which they can be enlarged or reduced in size.

Human Color Perception

Because all colors visible to the human eye can be approximated by mixing three primary colors, it was long believed that there were three receptor systems in the eye associated with color vision. However, recent research by Dr. Edwin Land has demonstrated that three primaries are not necessary to induce the sensation of full-range color vision in the human observer. In short, the eye can reconstruct full color from the scantiest clues, something that cannot be done photographically at present.

The more we learn about color, the more it seems to be in the eye of the beholder. If a photograph is taken under controlled conditions such that the photograph and the object held side-by-side under the same illumination will appear the same color, there is still no assurance that they will appear the same color under any other illumination. Fortunately, the adaptation process in vision allows us to accept considerable deviation from the "real" color of objects before they begin to look unnatural. Most people tend to describe color-rendering that they like as "natural," but there may be considerable variation between observers in what they prefer.

Even if color reproduction is controlled to the photographer's complete satisfaction, there is no assurance that another viewer would agree about the accuracy of rendition. In fact, we have no real way of knowing that another viewer even sees the same colors we do. People frequently live normal lives for years before discovering—accidentally—that they are partially color-blind.

Granted the subjectivity of color perception, the premise with which this column began bears restating. The photographer's primary concern should be to create a good picture—and knowing how to use color is a means to that end.

This list details the photographer, artist, or other source of illustrations, by page.

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12-19—Helmut Wimmer
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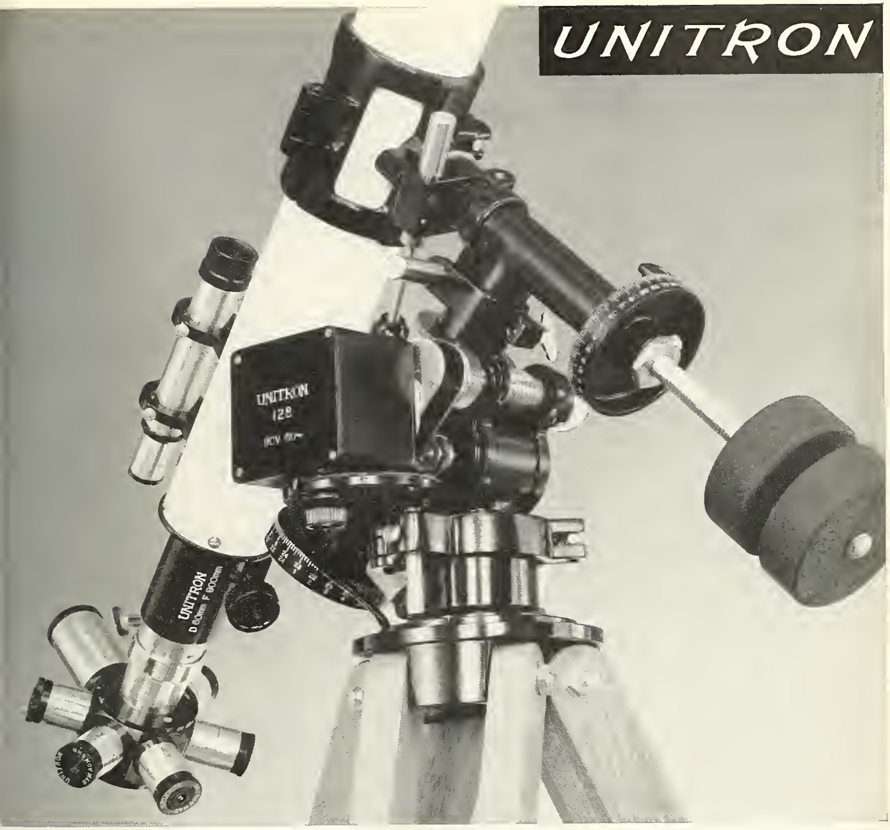

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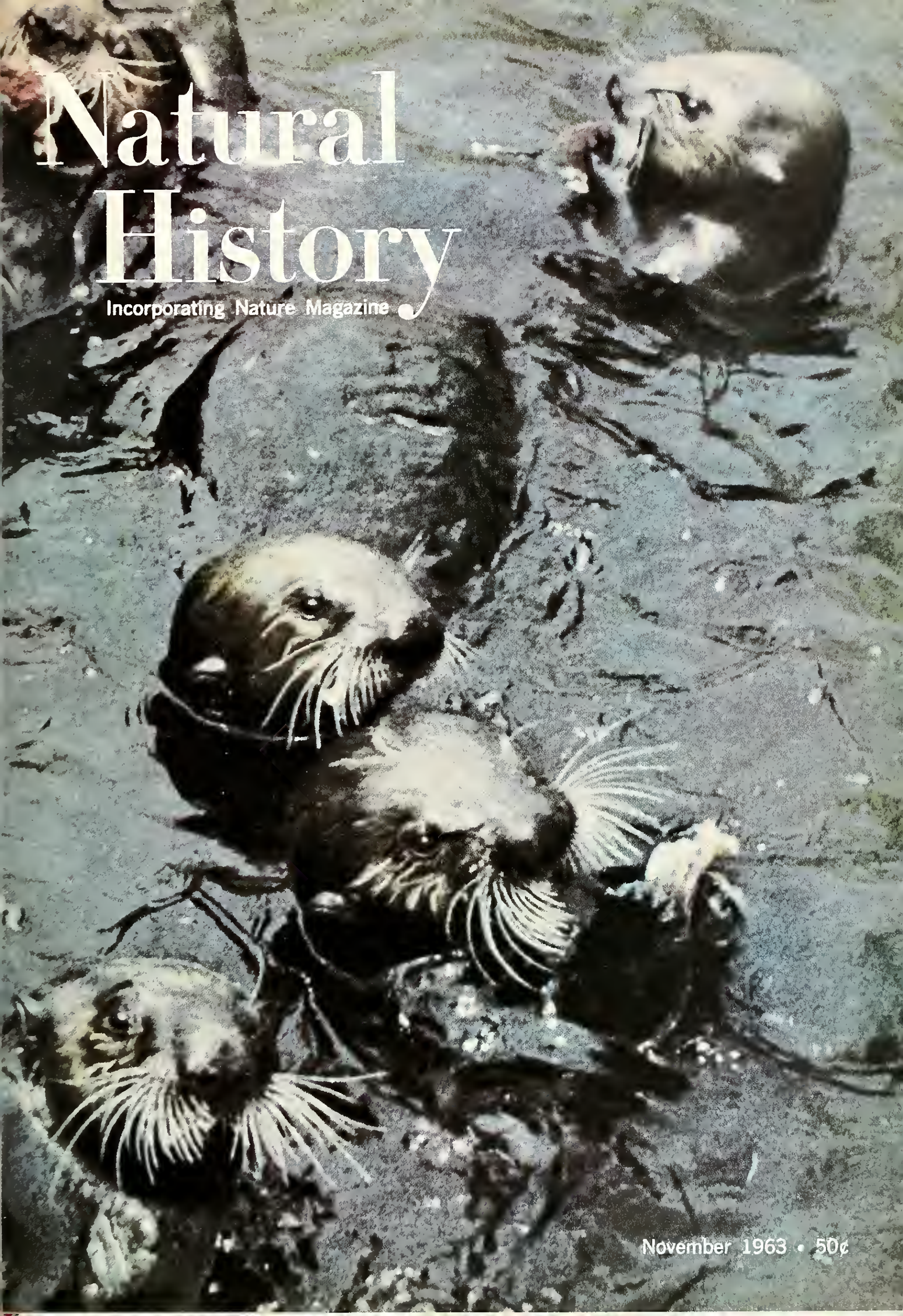

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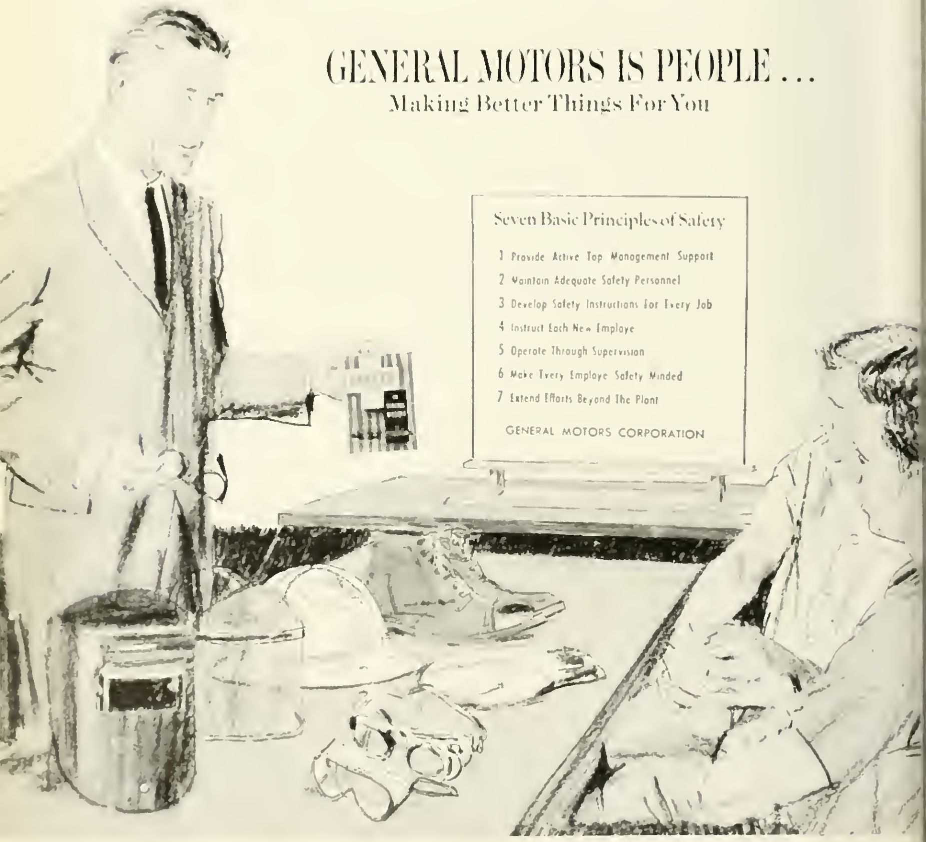
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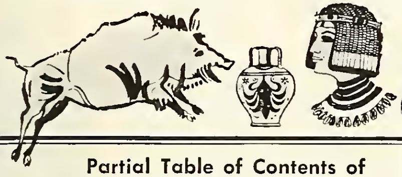

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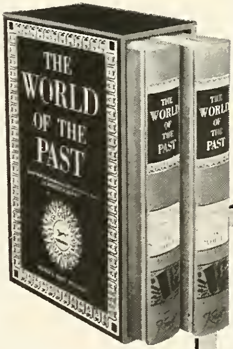

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COVER: These gregarious, white-whiskered animals, busily eating mollusks brought up from the bottom of the sea, have the most beautiful and the most costly pelts in the world—a distinction that brought them close to total extermination. They are sea otters, photographed here in kelp beds near the shore of Amchitka Island, far out in the Aleutian chain that stretches west from Alaska. Sea otters are smaller and more slender than fur seals. Otters usually swim on their backs, and often cover their eyes with their forepaws when resting. For more details about this engaging creature, turn to page 12.

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Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York 24, N. Y. Published monthly, October through May; bimonthly June to September. Subscription Price: $5.00 a year. In Canada, and all other countries $5.50 a year. Single copies $.50. Second class postage paid at New York, N. Y., and at additional offices. Copyright, 1963, by The American Museum of Natural History. No part of this periodical may be reproduced without the written consent of NATURAL HISTORY. The title NATURAL MAGAZINE, registered U.S. Patent Office. Unsolicited manuscripts and illustrations submitted to the editorial office will be handled with all possible care, but we cannot assume responsibility for their safety. The opinions expressed by authors are their own and do not necessarily reflect The American Museum's policy

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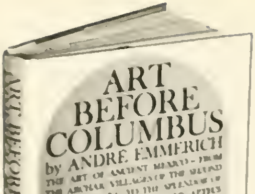

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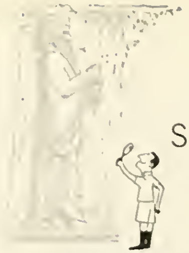

Reviews

Scholarly archeological works are highly readable fare

By Edith Porada

The Phoenicians, by Donald Harden. *Frederick A. Praeger, $6.95; 336 pp., illus.* The Art of the Hittites, text by Ekrem Akurgal, photographs by Max Hirmer. *Harry Abrams, Inc., $25.00, 288 pp., illus.* Biblical Archaeology, by G. Ernest Wright. *The Westminster Press, $10.95; 291 pp., illus.* The Greatness That Was Babylon, by H. W. F. Saggs. *Hawthorn Books, Inc., $9.95; 562 pp., illus.*

The interest in archeology seems to be unflagging, and more and more scholars realize they must provide a survey of their special fields if accurate information is to become available to the public—an ideal realized in four recently published, highly readable books.

Donald Harden, Director of the London Museum, has written a fine history of the Phoenicians. He is principally interested in their geographic situation and in the historical development that resulted from the utilization of their coast, with its islands, headlands, and bays. The Phoenicians were skilled navigators and shipbuilders who expanded the timber trade with Egypt. Such trade was essential to feed the growing population of the Phoenician towns, as little produce could be raised on the narrow strip of arable land between the coast and the wooded mountains of the Lebanon—the hinterland of Phoenicia.

Harden traces the history of the principal Phoenician town of Tyre. The outline of this ancient harbor can still be recognized, as can the mole that was built during Alexander the Great's siege in 332 B.C. However, excavations at the site have yielded little that can be dated before Alexander, so much of what is known of the early maritime ventures of the Phoenicians must be gleaned from biblical accounts. Passages in I Kings relate how Hiram the Great of Tyre helped King Solomon in the Red Sea trade and brought gold and precious stones from Ophir, and indicate the abilities of Phoenician craftsmen that Solomon employed to build and decorate his temple at Jerusalem.

Harden also says that the principal Phoenician objective for establishing the colonies of Carthage and Malta and the towns in Sardinia was to assure trading monopolies in the face of Greek competition. In fact, as the author points ou the Carthaginians did not only compet with the Greeks in trading ventures they also engaged in open warfare i Sicily, which ended only when the Romans conquered that island and defeate the Carthaginians in the Punic Wars.

Following this political history, Harden reconstructs Phoenician religiou beliefs on the basis of literary and archeological evidence. Thoughtful and informative chapters are also devoted t language and writing. The author eve manages to give a clear picture of Phoenician art in its different geographica phases. This art is chiefly known fo ivory inlays in furniture, delicately engraved metal bowls and stone seals, an jewelry. Various influences, chiefly Egyptian, were merged in the style of th Phoenician artists. The most distinctiv qualities of their art, says Harden, wer painstaking craftsmanship and design and ability to fit the object to its purpose

In contrast to Harden's unassuming handy volume, Ekrem Akurgal, Professor of Archeology at the University o Ankara, and Max Hirmer, who made sensitive and understanding photographs o ancient art, have produced a truly magnificent volume. This is a worthy membe of the art series published in Germany by Hirmer Verlag—and distributed here by Abrams—that contains Hirmer's excellent photographs of the art of antiquity, from Minoan and Mycenaean u to Mesopotamian. Professor Akurga has accompanied these photographs with competent surveys of Hittite architecture and sculpture so that the book may be used as a reference work. The colo plates are of almost three-dimensional quality and the high points in the artisti achievement of Anatolia, from the latte third to the early first millennium B.C., are laid before the reader. The plates also catch something of the clear air and the often imposing, beautiful Anatolian landscape in which Hittite and pre- and post-Hittite monuments are found.

The monochrome black-and-white plates, which comprise the bulk of the illustrations, are perhaps even more admirable. Here Hirmer has let each object speak for itself by his sensitive and understanding use of lighting and by his choice of the most characteristic angle or angles—for there are often two—instead of the less imaginative single three-quarter view. In the main, the works of Hittite and pre-Hittite art are small, but most of the photographs are not enlarged so much that they falsify the object as is so often done in current art books. Moreover, the measurements are usually indicated on the plate. It is regrettable that this system was not used in the photographs of rock reliefs and of seals and seal impressions. These latter artifacts are relatively small, although their inherent monumentality makes them appear larger in the reproductions.

Fortunately, many texts have been discovered from which scholars have reconstructed the history, religion, and rituals of the Hittites, and Professor Akurgal makes excellent use of them. I hope that a second edition will contain a better organized and more detailed bibliography. One of the most valuable sections of the book is the splendid presentation of the metal figures found in rich tombs of the Early Bronze Age, dated after the middle of the third millennium B.C. The people who inhabited Anatolia at that time, before the incursions of the Hittites, are called Hattians by modern scholars, and the tombs probably contained the burials of their kings. The figures from these Early Bronze Age tombs represent bulls, stags, and other animals, and may have been used as standards. They have simple but effective outlines, which convey the essential characteristics of young and strong animals. Sometimes the animals are combined in an extraordinary composition of many figures. These works of art come from a period when no Anatolian texts are known and none is now likely to appear, so speculations about the origin of the people who made the figures are based only on comparison with similar objects found elsewhere. Of these, late Bronze Age cart pole ornaments from excavations at a site on Lake Sevan in Armenia, and a stag of wood and leather found in a fourth-century B.C. tomb in the Altai area of Russia, dramatize the relations between these types of objects (as suggested many years ago by the excavator of the Hattian cemetery). This type of diffusion over such vast distances in time and space seems surprising at first, but is merely one of several examples that indicate a far greater exchange and migration of goods and ideas from and to ancient Anatolia than has been generally realized.

The last section of *The Art of the Hittites* deals with late Hittite art, including that of the principalities in which the Semitic Aramaeans had assumed the dominant position at the beginning of the first millennium B.C. Aramaean sculptures are often crude, but the stiff little people are convincing characterizations of a king and his scribe, priests and warriors — all on reliefs in the palace — and noblewomen spinning, depicted on their funerary slabs.

Like the Phoenicians, the Aramaeans were neighbors of the Israelites, too, and probably resembled them in appearance and gestures. It is quite legitimate, therefore, that photographs of Aramaean reliefs are used as illustrations in G. Ernest Wright's *Biblical Archaeology*. The foreword to the first edition of this work, published in 1955, sums up its purpose and contents: "to summarize the archaeological discoveries which directly illumine biblical history, in order that the Bible's setting in the ancient world and its relation to its environment may be more readily comprehended." The author, who is Parkman Professor of Divinity, Harvard Divinity School, made few major changes in this second edition. Some views of sites were exchanged for better ones, and results of recent excavations were incorporated in the text.

The background of the biblical narrative must be reconstructed from a mosaic of archeological details. As an example, Professor Wright surveys the

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Israeli excavations at Hazor where the architectural finds, such as the great city gate, were similar to those at Megiddo and Gezer These are all fortifications built by Solomon (related in I Kings), and he had imposed taxes to construct them. Other results from excavations in Israel could not be incorporated in the present edition, but there will surely be another one very soon.

Wright's book, however, is not limited to the time of the Old Testament; it also covers the Hellenistic Age an era when most of the books of the Old Testament were given the form we know today. This section is followed by a discussion of the Dead Sea scrolls from the library of a Jewish sect of the time of Christ. The relationship of this sect to Christianity, and particularly to the ideas of St. John, are interestingly summarized by Wright in his chapter on Palestine at the time of Christ. The last chapter, "The Church in the World," gives an account of the location of the first Christian communities and the lands the Apostles traveled. Few other works reconstruct the ancient scene as well as this one. The pages concerned with "the first major Christian center outside of Palestine, and the base from which Paul set out on his missionary journeys" are particularly well done.

THROUGHOUT most of Wright's book, the archeological evidence holds the chief interest of writer and reader. In the last book to be reviewed—H. W. F. Sagg's *The Greatness That Was Babylon*—the texts, however, are the principal source of information. The author, a lecturer on Assyrian and Babylonian languages at the University of London, subtitled his work "A Sketch of the Ancient Civilization of the Tigris-Euphrates Valley." This region is commonly called Mesopotamia when referring to the area before Babylonia rose to prominence about 1800 B.C. Professor Saggs duly explains all this in the chapter, "General and Political History of Mesopotamia Before 2000 B.C." The texts used by the author are written on clay tablets in cuneiform in Sumerian and Akkadian; the first cannot be easily classified in any of the known families of languages, and the latter is a Semitic language. The early forms of the cuneiform signs are intricate and vary considerably. Although cuneiform characters are not as difficult to learn as Chinese ones, this form of writing presents a major obstacle to the reading of a text. Even greater difficulties are presented by Sumerian sentence structure, the interpretation of various elements of words, and uncommon words that the dictionaries have not been able to record because of the thousands of texts excavated within the past forty years. The great new Akkadian dictionary, published by

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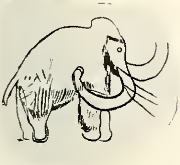

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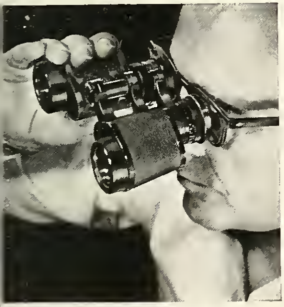

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the Oriental Institute at the University of Chicago, covers but seven letters, and one can only hope that the energy and devotion of the dictionary staff will allow completion of the alphabet. In view of the difficulties just described, and the resulting variety of opinions among cuneiform scholars, it was a gigantic task to bring up to date a summary of the textual information on the history, laws, administration, trade, economics, religion, government, literature, mathematics, and astronomy of Mesopotamia. On the whole, it is a task well done.

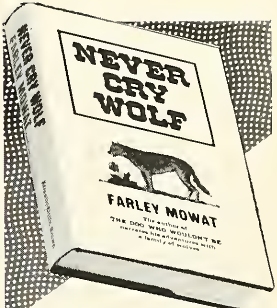
In general, recent results in Near Eastern archeology are available only in specialized periodicals published in large numbers. They contain more articles than even the professional has time to read. These four books are welcome, therefore, as they are solid summaries of recent archeological activities.

Dr. Porada, an expert on the Hittites, is Associate Professor of Art History and Archeology at Columbia University.

THE FISHES, by F. D. Ommanney. *Time, Inc., $3.95; 192 pp., illus.*

THERE are over twenty thousand species of fish. Among these myriad numbers—in fact, the greatest number of any vertebrate class—are seemingly endless specializations. For each ecological niche there is a species of fish to take up living there. Thus, when authors are asked to write a book about fishes, the problem is enormous. They are instantly faced with having to make choices, because they soon realize that there is no typical generalized fish. Broad sweeping statements are havens for misinterpretation. Yet, what can authors do?

This new book in the "Life Nature Library" is an example of what some authors did. They built a book around a series of truly superb photographs that show examples of fishes in different environments, displaying different habits and different characteristics. But the authors have run into trouble in the accompanying text, for they are trapped because the description of behavior or of anatomy for species A is not exactly the same as for species B. If they had really attempted to be careful and circumspect, this book would have been four times longer. The text is most readable, but unfortunately, in order to keep the cadence of writing, the art of writing half-truths has been invoked, and one set of qualities of one species melds into the qualities of another. For example, the first part of one paragraph describes the behavior of one species of mouthbreeding fish; the second part of the same paragraph describes behavior in another species. By implication, the reader assumes that the text is about a



A book about wolves

by FARLEY MOWAT

author of
The Dog Who Wouldn't Be,
Owls in the Family, and
People of the Deer

As official biologist for the Canadian government, Farley Mowat was ordered on a mission to the Canadian tundra to determine, in the official jargon, "the range population of *Canis lupus* in order to establish contact with the study species." His job was to find evidence to support a notion that wolves were slaughtering vast numbers of caribou in the Arctic. He found that they were not.

Armed with a vast amount of scientific equipment — and some ingrained prejudices — Farley Mowat landed on the ice of Wolf House Bay and proceeded almost at once "to establish contact with the study species."

Terribly funny, yet serious in its underlying purpose, NEVER CRY WOLF is the fascinating, first-hand account of Mowat's six-month acquaintance with a wolf family: George, the huge white male; Angeline, the graceful mother; Uncle Albert, the single male and baby sitter; and a family of four cubs.

Watching them with telescope and tracking them on foot, even venturing for a perilous moment into the den, Mowat made some extraordinary discoveries about *Canis lupus,* and he found that the wolf of fact is very different from the wolf of legend.

NEVER CRY WOLF will captivate all lovers of animals, while it offers readers the opportunity to make some amusing and surprising new wild animal friends. $4.95

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single species. In another place, the authors state that young fish do not develop a functional mouth until the yolk supply is used up—not so in all species. Further it is not only temperature but also light that is important in the reproduction of many fish and so on throughout the book. These examples are frightening, since the book contains essentially accurate facts alongside other accurate facts. But the two sets of facts are not always related, and by innuendo the reader may assume they are. The book is very pleasant to look at, however, and is certainly worth owning, if only for the photographs.

EVELYN SHAW

A TREASURY OF BIRDLORE, edited by Joseph Wood Krutch and Paul S. Erikson. *Doubleday & Co., $7.50; 390 pp.*

THIS anthology contains eighty-three essays about American birds. The well-known older authors—Audubon, Wilson, Muir, Bartram—are all represented. The editors were faced with a more difficult problem when dealing with recent writers. When they decided to pick articles for instruction rather than for entertainment, they sometimes lack the background essential for selecting authors who are scientifically sound. The illustrations are a mixed lot, and fuller captions would have added greatly to their value and interest. Despite thes shortcomings anyone interested i American birds will enjoy browsing i this volume.

DEAN AMADO

PATH TO ENCHANTMENT, by William Schaldach. *The Macmillan Co., $10.00 225 pp., illus.*

THIS book leaves me with mixed emotions, a reaction possibly due to th great number of books that have appeared in the last few years on th Sonoran Desert. Some of the others hav been written by specialists, and as suc have covered narrow subjects well. Mi Schaldach's book, however, is a readabl mixture of information—all of which i available from other sources—on a variety of subjects.

The author's sketches are generally good, and the black-and-white illustrations for most of his chapters are appealing and adequately recognizable. Thos done on the reptiles, however, leave to much to the imagination, and could no be used easily for identification. Possibly my reaction is due to years of museum work, in which photographic accuracy and detail is a "must."

Although the large frontispiece ma and the subtitle, "An Artist in the Sonoran Desert," intimates that the book covers the entire Sonoran zone, it betrays a woeful lack of knowledge of Baja California, a most interesting part of this ari wonderland. Despite this omission, th book is well done. Even subtle hints on tourist's behavior in Mexico are included One, which stresses the fact that it i we who are the foreigners and not th Mexicans, certainly coincides with som long-time views of my own. In addition there are some paragraphs on pronunciation of Mexican words and a pag or so on Mexican alcoholic drinks. So for anyone interested in the history both natural and otherwise, of the area from Tucson to Kino Bay the book i packed with useful information.

LEWIS W. WALKER

HINDUS OF THE HIMALAYAS, by Gerald D. Berreman. *Univ. of California Press, $8.50; 430 pp., illus.*

IN this book Dr. Berreman reports on studies he made from September, 1957 through August, 1958 in a hill village near Dehra Dun, in the lower Himalayas. His approach is that of a trained sociologist—objective, systematic, and thorough. The resulting book is well written, although occasionally, as in the chapter on kin groups, the author slips into technical approaches that make heavy going for the general reader. Sirkanda, a pseudonym for the real name of the village, is an agricultural-pastoral community of 384 people, 90 per cent of them high caste, and 10 per cent low and

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outcaste. The accurate, dispassionate chapters on caste, on the supernatural, and on kin groups and kinship, will cause the serious reader to marvel that these people are actually of the same race as those superior philosophers of an ancient culture whom propagandists and apologists for India have so persistently thrust upon us.

The student of American and world affairs will read the chapters on the village community and on the outside world with utmost interest. Never has the hollow façade of Indian government influence been so effectively stripped away as by this calm, accurate reporting of village government in action.

Finally, the cultural anthropologist, amateur or professional, will find here a wealth of material on northern Indian hill cultures. If he has had the advantage of close contact with Indian villagers, he will also find anecdotes and statements that will flood him with memories of *his* villagers, and will lead him to the conclusion that no matter how detached or objective the style, this author really knows his people.

This is not a book for a hasty or casual reader. But for the person seriously interested in India, Indian people, or Indian administrative problems it is an absolute necessity. One almost hopes that the author will some day take his naked facts about caste, family life, and village government, reclothe them with the cloak of personality, and present them in a narrative form that will attract a wider audience.

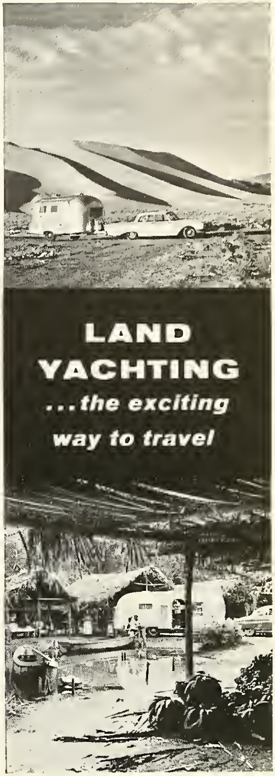
John Clark

Face of North America. by Peter Farb. *Harper & Row, $6.50; 316 pp., illus.*

This is a difficult book to review, because it is both fascinating and frustrating. It is fascinating in the broad view it gives one of the North American continent, and frustrating because the very broadness of this view necessitates brief and hasty—hence somewhat inaccurate and misleading—explanations of the whys and wherefores of the various features of the continent's face.

Marston Bates, in his introduction, writes that he will keep a copy in the glove compartment of his car. However, it seems to this reviewer that whatever view of the continent can be seen from a car is usually too limited in scope and too much shaped by man for this book to be of much assistance in understanding what one sees along a roadway.

The book takes a broad look and of necessity paints with a bold stroke. Rather than in the glove compartment of a car, this book belongs in the hand-carried luggage of the airline passenger. Here, particularly on a transcontinental flight, one can see the great bowl of the continent hemmed in by its peripheral



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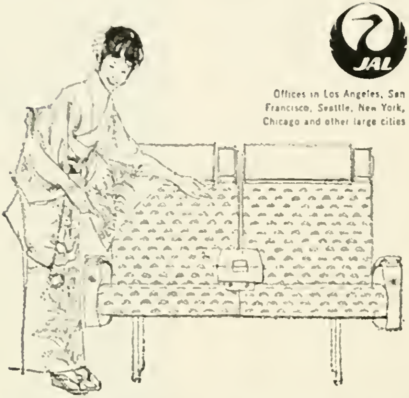


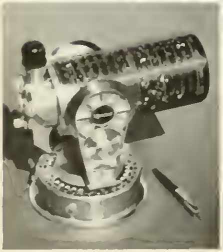
mountain ranges. One can observe for himself the broad coastal plains of the East Coast and the almost non-existent coastal plain of the West. One can see the forested eastern part of the continent shading into high, treeless plains. Here the mark of the plow and the hand of man have somewhat obscured the natural transition, but it can be seen. The great dry basin area between the Rockies and the Sierras stands out most clearly.

This book should be read by anyone who enjoys the broad view of the continent, because it emphasizes the never-ending give-and-take, the continual rising of land and continual eroding away. It dramatizes the growth and death of the continent's crust—a process that has continued through the countless aeons of time and will continue until, in future aeons, the planet dies.

T. K. SHARPLESS

GROWING WINGS, by Sarita Van Vleck, *Doubleday & Co., $3.95; 128 pp., illus.*

How should one write about the natural world? How much does one need to know before starting to write? How should the basic biological facts fit in with fancy and appreciation? And to what extent should sentiment and emotion influence the writer?



This happy-looking serpent has mighty good reason for that contented look, because nobody is crowding him, chasing him, or in any way frightening him by getting too near.

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The book said he was a Yellow Rat Snake, Elaphe Quadrivittata. It said he was harmless, though almost 7 feet long. Not being experts, our Questar owners were relieved not to have to get much closer to this big fellow. And that, of course, is why they enjoy their Questar so much — they can study the wildlife minutely without alarming it.

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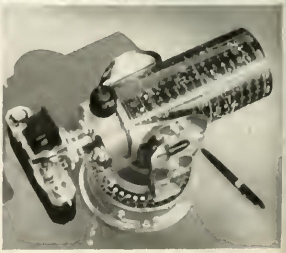

On the other hand, the problem of the critic asked to appraise the work is to separate the wheat from the chaff. This is becoming increasingly difficult, as more and more books on the natural world move onto the market. We have the professional and we have the amateur, and in-between we have the nature lover who knows a little but not enough, who wants to write anyway, and does, and gets published.

Sarita Van Vleck's book, which undertakes to follow the life of birds through their annual cycle, is a very nice, unpretentious book, and there is some almost lyrical prose in it.

However, one sentence in the book is unworthy of a graduate of Vassar, the author's alma mater: "With life centered around a wet habitat, the Redwing would be unlikely to nest in its absence." Even if something could center *around* something, the line would be a horror.

This is quibbling, of course. Miss Van Vleck's book has the right spirit and is aimed in the right direction, and even if she falls into the trap of filling it out with biological notes gleaned from here and there, it is to be hoped that she will write another one. Obviously she could, in spite of the competition, and the field is wide open.

PIETER FOSBURGH

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Recovery of a Fur Bearer

Coveted pelt caused sea otter decimation

By Karl W. Kenyon

THE SOUND OF WAVES in a small cove was all but lost in the roar of wind among rocks and the pounding of storm surf along the open outer coast of Amchitka Island. A typical Aleutian storm had nearly passed. Behind it the sky was clear, and winter sunshine glistened on heaps of sea foam that blended on the black pebbly beach with snow fingers that reached to the sea among tumbled boulders.

In the shelter of the rocks more than one hundred sea otters had taken refuge from the battering sea. Most rested on their backs. Some slept, their forepaws against their cheeks or over their eyes. Others rubbed, fluffed, and licked their inch-long, dark brown fur. Many lay alone but others sprawled in groups of five or six. The nearest was only twenty feet away. I approached slowly, keeping my silhouette below the horizon and shielding my approach behind rocks. Fortunately, the wind was from the sea, for the sense of smell is well developed in the sea otter. All would now be in the water had my scent reached them. (It is a boon to the curious zoologist that the animals have poor vision. A strange shape on the skyline or a quick movement causes instant alarm and a hurried scramble for the sea, but cautious movements go unnoticed or perhaps are mistaken for those of another otter.)

John Nevzeroff and Innokenty Golodoff, both residents of the Aleutians, followed close behind, each carrying a large landing net of the type used by sport fishermen. Each selected an animal and ran the last ten feet to pop the net over it while the other otters escaped into the sea. Using their nimble forepaws like hands, the netted otters attempted to disentangle themselves. While they were thus occupied, it was a simple operation to grasp a hind flipper and, using special tagging pliers, attach the Monel cattle eartag to the web of the hind flipper. When liberated, both plunged into the water. Forty feet away they surfaced to gaze at us, as if in amazement, as they paddled on their backs toward more open water. Both seemed unconcerned by their shiny new adornments. Because the sea otter is often gregarious, our tagging studies have not progressed rapidly. Miles of beach must usually be searched with only a few tagged otters to show for it.

ANOTHER method of capture has been successful only once. A young male otter often frequented the area just offshore from the place where we daily cleaned fish. Soon he learned that the fish heads we tossed him were an easy source of food. Within a few days he would come to the water's edge to take fish heads from our hands. In another week he emerged from the water and followed us about, demanding food. It was an easy matter, while one of us handed him a fish, for another to grasp his hind flipper and place the tag on it. Unperturbed by this brief rough treatment, he tucked his food in the loose fold of skin across his chest, and holding it there with one forepaw returned on three legs to the water for his meal. This was the easiest tagging operation we experienced.

In summer months when the sea is calm, otters seldom come ashore except at night, and even then the majority sleep floating in a favorite kelp bed. Some can be captured from a boat with a dip net, but pursuit is difficult

SEA OTTERS gather clams from the ocean bottom with their dexterous forepaws.

because visibility is poor in the usually rough and murky water, and kelp beds hamper outboard motor operation.

The capture, marking, and releasing of otters on Amchitka make up an important part of the marine mammal studies of the Fish and Wildlife Service, United States Department of the Interior. Individual animals that can be recognized can give us, over a period of years, valuable information on age, longevity, movements, and other life habits. Other studies will be discussed later, but here it seems appropriate to describe some of the characteristics of the sea otter.

The sea otter, *Enhydra lutris*, in addition to the river otter, mink, and skunk, belongs to the family Mustelidae. It differs from its relatives, however, in many significant ways and also possesses characteristics unique among marine mammals. It lives exclusively in the marine environment. Since the otter gathers its food from the bottom and its dives are seldom deeper than 120 feet, it usually remains near shore. It apparently prefers depths of from 10 to 70 feet, and in most areas this means that the majority of sea otters are found within about one-half mile of shore. Their molars are broad, flat, and adapted to crushing shells of sea urchins, mussels, snails, and crustaceans on which, in addition to fish, they feed.

In the order Carnivora, the sea otter is the only species that has only four incisor teeth in its lower jaw: its broad cheek teeth are also unique. The sea otter is nearly three times as heavy as the river otter—adult males usually weigh between sixty and eighty pounds and measure about four and a half feet in length; females usually weigh from thirty-five to sixty pounds. While on the surface, the animal ordinarily swims belly up, propelling itself by alternate strokes of the broadly flattened, webbed hind feet. It never eats on land, unless compelled to do so in captivity. The sea otter's long, soft fur gains beauty but little protection from the sparse guard hairs. It is dexterous with its forepaws, with which it both gathers food from the sea floor and preens its fur. Its unusual habit of breaking the shells of invertebrates on a rock held on the chest has often been described.

Among marine mammals the sea otter differs from seals, porpoises, and whales in that it lacks an insulating subcutaneous blubber layer. For protection from the cold water in which it lives it depends entirely on a blanket of air trapped among the long, soft fibers of its fur. The sea otter's shallow-water feeding habits limit its range, so it may not traverse vast reaches of the sea as do most other marine mammals.

Like most other marine mammals, too, sea otters bear but one young at a birth, but the pup may be born at any time of the year. Soviet biologists record twins, but I doubt that a mother could successfully rear more than one pup at a time. The pup is relatively large at birth, weighing from three to five pounds, and is carried, nursed, and groomed on the mother's chest as she swims on her back.

In temperament, the sea otter might be termed tractable and "friendly." Most animals accept food from the hand within a day or two of capture, some even within a few minutes. "Old-timers," in captivity two weeks or more, rush from the water at feeding time, rise on their hind legs, rest their forepaws against the man holding the fish bucket, and plead with eager eyes for a handout. Under such circumstances the otters are careful not to bite the hand that feeds them. If, however, an animal is forcibly restrained, or a sick one is handled, a painful bite is a not-unusual result.

Often I have marveled at the restraint exhibited by an adult attempting to sleep in a kelp bed. Adolescent otters appear to derive delight in tormenting such individuals. The young otter stealthily approaches the sleeper during the usual mid-afternoon siesta hour, and then suddenly bounces from the water and comes down with both

At midday, during calm weather, sea otters usually retire to kelp beds for a rest. They sleep on their backs, and often place the forepaws over the eyes.

Young otter is carried, nursed, and groomed on mother's chest and abdomen as she swims on her back, although the pup is relatively large at birth. For about a year, the pup is given constant attention and most of its food by its mother.

front paws on the victim's chest or abdomen. A five- to ten-minute period of play may follow, while the reluctant adult slowly edges away and finally escapes to a distant kelp patch to finish his nap, and the ever watchful mother takes her offspring in hand.

I have only once seen what I would interpret as a fight between wild otters. They apparently exhibit no territorial aggressiveness—not even during the breeding period. Even adult males, although engaging in a spirited tug of war over a fish, seldom attempt to bite or snap at each other. In captivity, when food is short and must be rationed—as is occasionally the case when storms prevent fishing activities —the larger animals steal food from the smaller ones.

The early history of sea otter hunting constitutes a prime example of what may occur when exploitation of a natural resource is unregulated and avaricious. The voyages of Vitus Bering in 1741 and of Captain Cook in 1779 brought knowledge to the world of the vast riches in fur along the coasts of the North Pacific and Bering Sea. A flood of fur hunters, the *promyshlenniki*, rushed eastward from Kamchatka. Many came in small, flimsy, and unseaworthy ships and were lost at sea. Pushing west and north from the New World to meet the Asians came Europeans under several flags. The men who dreamed of wealth through fur, and who were willing to bear the hardships of obtaining it, were relentlessly greedy, rough, and cruel. The stories of their mistreatment and often murder of the native Aleutian and Northwest Coast Indians comprise a shameful chapter in human history. Aborigines were often enslaved and forced to leave their homes to hunt sea otters, while their tormentors stayed comfortably ashore in the villages and stole their wives.

Treatment of the sea otter was equally unreasonable. Every animal that could be found was killed, including mothers with young. It is recorded that within a year of the discovery of the Pribilof Islands, 5,000 sea otters—nearly the total population on these islands—were killed. In a few years the last survivor was hunted down.

This method of total exploitation continued through a period of about 170 years. By 1900, sea otters were so scarce that men spent months afield to obtain one or two skins. Still, protection was not given the nearly extinct species until 1911, when an international treaty was negotiated to protect the northern fur seal, and the remnant sea otter population was included incidentally.

Recovery of the pelagic, migratory fur seal on its Pribilof breeding ground was relatively rapid. By 1918 limited exploitation was possible, and during the 1940's the population had approached its maximum natural limits. Not so the sea otter population. Only in scattered and isolated Alaska areas have island colonies now reached their natural maximum population. Amchitka Island is one of these,

To BREAK THE SHELL, a captive sea otter pounds one clam held in her forepaws against another one lying on her chest.

and it is here that most of the studies of the Fish and Wildlife Service are being conducted. At other isolated places, small colonies are growing slowly, but today extensive coastal areas in southeastern Alaska, British Columbia, Washington, Oregon, most of California, and Lower California that formerly supported sea otters remain unoccupied. Population growth is most rapid where islands are not separated by wide expanses of deep water. In such areas, sea otters increase locally. Then, as large population needs increase, the animals move to a new island, and thus a step is taken toward reoccupation of their former range.

REFUGE SUPERVISOR David L. Spencer and I have observed such population movement at Adak Island in the Aleutians. On my first visit there in 1947 I saw no sea otters, and no one at the Adak Naval Station had seen one. Kanaga Island, however, about ten miles to the west, had a good population. By 1954 Refuge Manager R. D. Jones saw a few otters at Adak, and thereafter the influx was rapid. We counted 2,260 otters during an aerial survey of the island in 1962.

One of the original objectives of the sea otter studies of the Fish and Wildlife Service was to expedite the reoccupation of former sea otter range through transplants. The first two attempts, made in the winter of 1950-51 and in 1955, failed because sufficient knowledge of the requirements of sea otters in captivity was not available.

An evolutionist might say the sea otter has reached a "dead end" because of the narrow range of ecological conditions under which it may survive. Its food requirement is large. A young animal weighing twenty-five pounds requires at least six pounds of fresh food daily, and it eats only fish or invertebrates. (Rarely, during food shortages, they have eaten bird flesh, but it apparently passed undigested through the gastruintestinal tract.)

ONE important barrier between life and death for sea otters is the delicate fur. It must be protected from wear and soiling, and it is easily damaged in cages. In practice, this means that if numbers of otters are to be moved successfully over a long distance, a large pool of clean water must be constantly available. If sea otters in small cages are fed the slimy food they require, their fur quickly becomes soiled, thus losing its insulating qualities, and the animals succumb to exposure. Obviously a large vessel would be required to carry a significant number of otters from an area of abundance to unoccupied habitat.

An alternative is rapid aerial transportation in a large, unheated aircraft. In 1959, we successfully transplanted seven sea otters a distance of nearly

In the wild, these "tool users" often place a rock on their chest and crack open the hard-shelled mollusks upon it.

500 miles from Amchitka to St. Paul Island in the Pribilof group. The flight required 4.3 hours, so that it was not necessary to feed the animals in transit. Although the cabin temperature was maintained at 49°F. (to the great discomfort of human passengers), the otters in their thick fur coats suffered from heat distress and had to be doused frequently with cold water. They were all in fine condition when liberated; each accepted a fish as it left its traveling cage and paddled out to sea. They are still sighted occasionally, but it is not yet known whether or not such a small group will ultimately reproduce and form a new colony on the Pribilofs.

Sufficient knowledge is not yet available concerning the behavior of transplanted animals. For example, will they disperse when liberated and thus fail to reproduce? An extensive and, so far as known, uninhabited area of former sea otter habitat exists in the coastal waters of southeastern Alaska. If, at great expense, sea otters were liberated here, what would become of them? During the fishing season this area is occupied by large numbers of fishermen. By tradition, fishermen shoot at predators such as seals and sea lions. Being relatively trusting, sea otters might be mistaken for seals and killed. In addition, they would be vulnerable to poachers.

WHAT are the chances that sea otters will repopulate the entire former range along the Pacific coast of the United States and Canada? I am not optimistic about their chances. I believe that polluted waters will prevent their survival in or near harbors close to large centers of human population. Again, the difficulty lies in the extremely soft and delicate fur, which is protected only to a minor degree by its few, scattered guard hairs. If even a small amount of oil floating on the water surface coats the fur fibers, the insulating properties are lost. Soiled and wet animals, unprotected from the cold sea water, soon chill and die.

Recently I hiked for about ten miles along the outer beaches of the Olympic Peninsula of Washington State. At sea, large ships often passed to or from the Strait of Juan de Fuca. Almost every rock I saw or touched was stained with oil. A black, sticky substance is formed when fuel oil residue and sea water mix, as they do when ships "pump their tanks" on leaving or approaching port. Unless such conditions as exist today on the outer coast of the Olympic Peninsula are corrected, there is little hope of re-establishing sea otters.

In the 1740's, when the exploitation of the sea otter fur resource began, the species ranged from central Baja California, Mexico, around the rim of the North Pacific Ocean to the Kurile Islands and the Asian coast. Although

WINTER WAVES pound rocks on which an otter preens. Air blanket trapped in fur fibers protects animal, which has no blubber layer, from the icy waters.

YOUNG MALE is wakened from his nap among patches of snow and dead grasses where he took refuge from waves that make rest and feeding at sea difficult.

its latitudinal range was great, its habitat was rather uniform. Northern limits of its range barely overlapped the southern limit of the pack ice in the Bering Sea—at the Pribilof Islands and near the western end of the Alaska Peninsula. Judging from the prosperous sea otter colonies in the Aleutians and in other places where the sea never freezes, we might conclude that these areas offer optimum habitat conditions. A colony at the northern limit of the range—in Prince William Sound, where winter cold is more intense than in the southerly arc of the Aleutians—is increasing and extending more slowly than are the Aleutian colonies.

Today, after fifty years of complete protection, the sea otter has reoccupied less than one-fifth of its original lineal coastal range. Extensive aerial surveys in Alaska, conducted by the Fish and Wildlife Service and the state of Alaska, place the otter population today between 20,000 and 30,000 animals. Some estimates exceed the higher figure, but I believe, on the strength of our surveys, that the more conservative figure may be much nearer the true facts.

BECAUSE of Amchitka's isolation and large local population, a vital aspect of our study there is to document and analyze natural mortality. Many observations during field studies have enabled us to piece together the story of how much of the winter mortality may occur there. Let us follow a juvenile otter during the last several weeks of his life in late winter. This young otter was born in the preceding spring and, although weighing about twenty-five pounds, was still in the company of his mother. Although her two mammae yielded little milk, she still allowed him to nurse occasionally, but both obtained most of their food by diving among the extensive offshore reefs. The young one, however, often wasted time in play, and he demanded and received food gathered by his more skillful and industrious mother. This way of life continued into February, when storm waves and the minute size of nutritious sea urchin gonads and the dearth of other food organisms made it difficult for the mother to feed both her pup and herself.

One afternoon in early February, after a busy period of searching for food, mother and pup slept near each other in a kelp bed. The pup, his belly full, slept soundly. The still-hungry mother rested only briefly, then quietly swam off to another feeding area. Her search for food carried her far. When her pup awoke and found himself deserted, he cried and searched about the reefs and kelp beds for his mother. He continued looking for her until the next day and took little time to search for food. Driven by hunger, he eventually began a serious hunt for food, but for years many otters had searched this rock bottom. He found plenty of the small sea urchins, but these immature invertebrates are almost valueless as food. He found little else he could eat. The shells of most snails were too hard for his immature teeth to crack. The numerous fish, often caught and eaten by strong adults, were too quick for his inexperienced grasp, and his strength was inadequate to hold and kill the occasional one he managed to capture. Unable to find anything else, the young otter continued to stuff himself with sea urchins.

A series of storms swept Amchitka during February. The first ones lasted only a day or less, and the young otter slept them out curled on a bed of rye grass behind a sheltering boulder. His inadequate diet and interrupted feeding schedule quickly reduced the reserve of body fat accumulated with his mother's help during the previous fall. An early March storm brought three days of heavy seas, high winds, and below freezing temperatures. Most of the first day the young otter slept on shore. Then, driven by hunger to search for food, he ventured into the breakers. The wild sea tossed him about and soon, exhausted and shivering, his stomach only half-full of sea urchins, he retired to his sleeping place. He preened and dried his fur, then curled up to sleep. In this position we found him dead next morning. An autopsy revealed not a trace of fat remaining on his body. His stomach and intestines contained the remains of about a dozen small sea urchins, and a quantity of black, tarry, fecal material. These are the symptoms of enteritis that appear to result from stress, starvation, and exposure, and are typical of the majority of dead sea otters found on Amchitka beaches. Farm animals that die of bacterial enteritis resulting from conditions of stress show similar symptoms.

A few otters were found dead of other causes—a broken neck, an infected wound, cancer. Old animals die when their cheek teeth become worn to the gumline—sometimes even to the bone—and the symptoms of emaciation, stress, and terminal enteritis are similar to those of the juveniles.

The mother sea otter gives her pup constant care and attention for about a year. Even when it is three-quarters her size, the mother otter furnishes much of the pup's large daily food re-

Care of fur is of vital importance in the life of otters, and preening, as by this adult male, is frequent. If soiled, the soft fur loses its insulating properties, and as a result the animals may quickly die from chill and from exposure.

quirement, and a tagged mother and pup revealed what may occur as a result. We captured the mother with her large pup resting on a favored beach. After their flippers were tagged, the two swam out to sea side by side. A succession of stormy days followed, after which we found the pup alone on the beach and dying of starvation. A few days later and about four miles away, we found the mother dead and in an emaciated condition. Perhaps she had tried too long to satisfy the considerable food needs of her half-grown young one and herself. Even in her run-down and weakened state she had not deserted her pup until she herself was beyond recovery.

I am sometimes asked the question: "Since sea otter fur is so valuable, what is the possibility that the animals might be captured in areas of abundance and bred in captivity for the fur market, as is done so successfully with mink and foxes?" Aside from a low reproductive rate, the difficulties of transporting sea otters and of furnishing adequate facilities for healthy existence in captivity pose real problems. I believe that another important reason why sea otters will probably not become fur farm animals is the high cost of their required food. This was graphically expressed by Mr. Edward J. Johnson, Director of the Woodland Park Zoo in Seattle. After he had cared for a captive female in his zoo for about two years, he remarked one day, "You know, your sea otter is a bit of a strain on our budget here. I've recently figured it up, and she eats more than a lion and costs more to feed than an elephant!" This statement may have been a slight exaggeration, but our experience with many captive animals has shown that each animal, if it is to remain vigorous and healthy, must eat at least one-fourth of its body weight per day.

Limited exploitation of the sea otter resource is reasonable today in very circumscribed areas, such as Amchitka Island. That population has stopped growing and may, in fact, have regressed in recent years. Today the number of sea otters there, approximately 2,000 to 3,000, has exceeded the limit that food resources can support, and each winter season of heavy storms leaves many otters dead in its wake. Unfortunately, Amchitka is isolated from other islands by wide, deep straits, and animal movement to new areas is insignificant.

Modern exploitation of the sea otter resource was begun by the state of Alaska in 1962. One hundred and fifty were taken by state biologist L. Croxton and his aide at Amchitka. Because sea otter furs have not entered the commercial market for more than fifty years, modern furriers look forward questioningly and with interest to the reaction of the fur-buying public to the sale of these skins. Regardless of the degree of modern acceptance of what our ancestors considered the fur of royalty, few will be able to possess even a sample of sea otter fur. The present-day total world population of sea otters, based on Soviet biologists estimates for the Kurile and Commander Islands population and ours for Alaska and California, is probably between 25,000 and 40,000 animals. The Alaska population is roughly 25,000, which, optimistically, migh yield a crop of about 1,000 skins annually. Against this figure place tha of the Alaska fur seal herd of abou 1,700,000 animals, which may produce a sustained yield of about 5 pe cent, or 85,000 skins, per year.

In addition, the sea otter appears t have a reproductive capacity tha is roughly half that of fur seal. Whil the female fur seal often produces on pup annually, a co-operative study now in progress by Dr. Clinton H Conaway and Fish and Wildlife Service biologists indicates that two years usually elapse between births in the se otter. Thus, unless young sea otter survival exceeds that of young fur seals the former could maintain its population only if it were cropped at one-hal the rate that is considered acceptabl for the fur seal population.

The sea otter is such an interesting and charming animal to observe in the wild and in captivity, that its covete fur coat seems a misfortune. We ca only hope that the seed populations o this animal, where range extension is occurring, will be most carefully guarded against exploitation of any kind

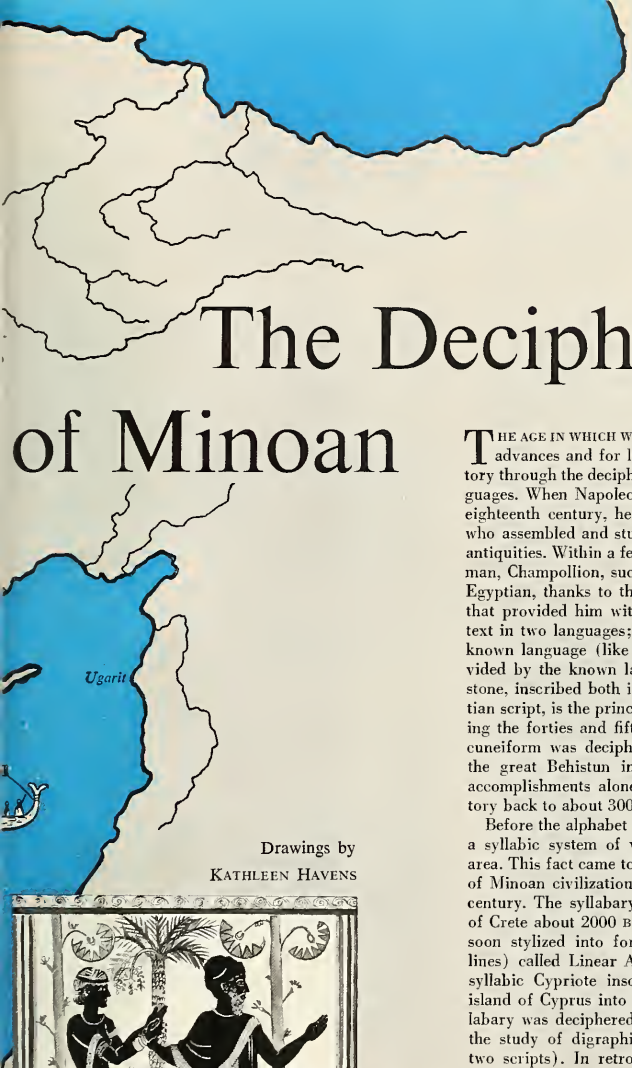
Workers net an otter for banding just before it dives from its resting spot.

Animals must be approached stealthily, for they are capable of swift movement.

Unconcerned pup, a month or two old eats a piece of fish it holds in paws

GREECE
CRETE
CYPR

The close relationship between Hebrew and Greek culture and tradition is supported in the ancient literature in many ways. For instance, in the Homeric legend, Menelaus recovers Helen from the palace of Priam, above. Genesis relates the way Abraham recovers Sarah from other kings, right.



By Cyrus H. Gordon

The Decipherment of Minoan

Drawings by
Kathleen Havens

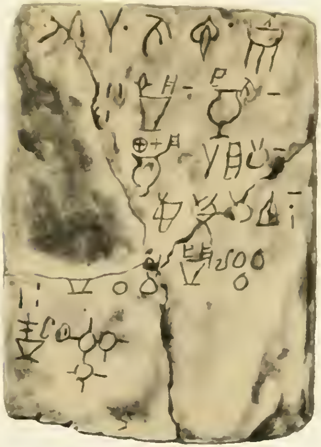
The age in which we live is noteworthy for its scientific advances and for lengthening the span of written history through the decipherment of forgotten scripts and languages. When Napoleon invaded Egypt at the end of the eighteenth century, he took with him a staff of scholars who assembled and studied a large collection of Egyptian antiquities. Within a few decades a brilliant young Frenchman, Champollion, succeeded in deciphering hieroglyphic Egyptian, thanks to the use of Greco-Egyptian bilinguals that provided him with the key. A bilingual is the same text in two languages; the decipherer breaks into the unknown language (like Egyptian) by using the clues provided by the known language (like Greek). The Rosetta stone, inscribed both in Greek and in two kinds of Egyptian script, is the principal Greco-Egyptian bilingual. During the forties and fifties of the last century, Babylonian cuneiform was deciphered, thanks to trilinguals such as the great Behistun inscription of Darius I. These two accomplishments alone threw the written records of history back to about 3000 B.C. in Egypt and western Asia.

Before the alphabet was used in the east Mediterranean, a syllabic system of writing had spread over the entire area. This fact came to light with Arthur Evans' discovery of Minoan civilization at the dawn of our own twentieth century. The syllabary came into existence on the island of Crete about 2000 B.C. in pictographic form, but it was soon stylized into forms (with fewer curves and more lines) called Linear A and B. From it also stemmed the syllabic Cypriote inscriptions that were written on the island of Cyprus into Hellenistic times. The Cypriote syllabary was deciphered in the nineteenth century through the study of digraphic texts (the same texts written in two scripts). In retrospect we now know that the Cypriote syllabary was descended from the same system that produced Linear A and B. Several of the signs are identical in form and sound in Linear A and B on the one hand and in the Cypriote syllabary on the other. But cautious scholars, maintaining that the phonetic value of a given sign might be completely different in the two sets of inscriptions, held the field, with the result that the decipherment of Cypriote played no role in deciphering Linear A and B.

Among a handful of adventuresome spirits trying to decipher the Linear B tablets after World War II was a young

British architect named Michael Ventris. After years of futile labor he gave up his hypothesis that the Linear B documents were related to Etruscan, and approached them on the assumption that they were, instead, Greek. The story of his success in 1952 and the implications of his decipherment have been described in NATURAL HISTORY (March and April, 1961) by John Chadwick. Ventris' achievement settled the question of the linguistic identity of the Achaeans depicted in Homeric epic. They were Greeks, using the Greek language. The Linear B tablets are the administrative records from the palaces of the heroes who fought at Troy to retrieve, as the *Iliad* would have us believe, the beautiful Helen. Archeologists have found Linear B tablets at Mycenae, the city of Nestor, and at Knossos, the city of Idomeneus — two of the Homeric heroes. The deeds of the Achaean heroes at Troy are appropriately enshrined in the poetry of Homer; the economic records of those same heroes are preserved on clay in the most jejune prose of Linear B. But the epics of Homer and the Linear B tablets are written in one language: Greek.

THE Linear B texts deciphered by Ventris were recorded in a script with various kinds of signs. Some were pictographs, portraying the objects they designated. Some were ideograms, standing for whole words. Others were determinatives, indicating the category of the words to which they applied. A small divider separated words from each other. Numbers were indicated with numerical signs instead of being spelled out phonetically. But the character of the language was indicated by the syllabic spelling of most words and most of the proper names. Each sign in the syllabary began with a consonant and ended with a vowel. Thus, a word like English "posters" would have been spelled *po-so-te-re-se*. Just as this kind of spelling would disturb the average reader if he were confronted with English written in the Minoan syllabary, a few conventional Greek scholars went so far as to say that the Greek language could not possibly be written in such a script. Today, however, there are only a few Hellenists who doubt the essential validity of Ventris' decipherment.



Minoan administrative tablet, known as Text 31, was found at Hagia Triada, a Cretan palace site. Its pictographs led to the Linear A decipherment.

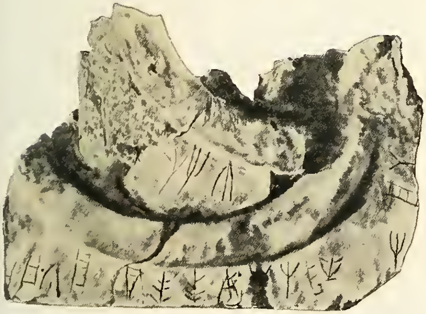
Inscribed libation table, found in Crete, has a dedication to the popular Minoan god Yashashalam, written similarly to many west Semitic tongues.

The Linear B tablets, which began to appear in the fifteenth century B.C., are called "Mycenaean" after the Mycenaean Greeks who wrote them. The earlier Linear A tablets were written by the Minoans, who preceded the Mycenaeans. Since many Minoan names were taken over by the Mycenaean Greeks, the syllabary of Linear A is essentially the same as that established by Ventris for Linear B. The Minoan Linear A name *ku-pa-nu* had obviously been borrowed in Linear B as *ku-pa-no*. Other names such as *pa-de* are identical in the two sets of inscriptions. Just as names such as "Maurice" and "Charles" occur in both French and English texts and thus show that the letters of the alphabet have approximately the same phonetic values in French and English, so, too, the occurrence of identical names in the A and B tablets indicates that the syllabic signs were pronounced more or less the same in Minoan A and Mycenaean B, even though the languages are different. Thus, the unlocking of the B texts automatically made possible the decipherment of the A texts, provided the A language belonged to some known family of languages. All that was needed was the opening wedge.

The year 1929 had ushered in a new era in Near Eastern studies with the discovery of the Ugaritic tablets dating from about the fourteenth century B.C. A French expedition then began to uncover hundreds of clay tablets in the mound of Ugarit, along the coast of Syria at the point nearest the island of Cyprus. The Ugaritic texts were written in a hitherto unheard-of alphabet. The script was deciphered in 1930, only a year after the first Ugaritic tablets were found. The Ugaritic language turned out to be a northwest Semitic dialect closely related to Phoenician and biblical Hebrew. One peculiarity of the literature could have provided the key to the Minoan problem — the Ugaritic god of arts and crafts had a pure northwest Semitic name, even though his workshop was located on the island of Crete, and in retrospect we can see that Ugarit looked to Crete as the traditional center of its civilization. Moreover, the Semitic name of the god indicates that Ugarit and Crete had belonged to the same linguistic sphere, but no one had the foresight to see it. As is usually the case, we perceive things better through hindsight.

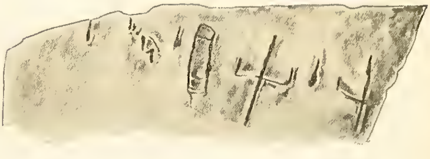
In 1940 the Pontifical Biblical Institute in Rome published my *Ugaritic Grammar*. World War II had already enveloped Europe, and America was soon to be drawn into the conflict. In the spring of 1942, I began work with the Army Signal Corps as a cryptanalyst, breaking enemy codes and ciphers. My linguistic studies had given me a background of value for cryptanalysis, and now cryptanalysis was providing me with a background for deciphering ancient texts. Hitherto, I had been able only to refine our knowledge of the languages whose basic elements had been deciphered by pioneers who had preceded me, but now for the first time I found that I was being initiated into the procedures that permit the cryptanalyst to break into completely unsolved codes and ciphers.

On being separated from the Army early in 1946, I resumed my civilian career as professor of Assyriology and Egyptology. I was working on a variety of scripts and languages of the east Mediterranean, but the Cretan problem was little more than one of several peripheral subjects of which I was aware. In 1947, when my *Ugaritic Handbook* was published, I went on record as hinting at a possible tie-in between Ugarit and Crete.



Fragments of one table yielded a dedication "to . . . Yashashalam so that the city may thrive." A sect in modern Iraq and Iran still worships the god.

The scribes of ancient Crete had a number of professional habits that were reflected in the B tablets, and one of them confirmed Ventris' decipherment. In preparing an inventory of jars and tripods, a scribe from Pylos supplemented the verbal descriptions of the objects with pictographs that showed their essential details. For instance, a pair of tripods were pictorially described by a tripod followed by the numeral "two," associated with the alphabetic entry *ti-ri-po-de* = *tripode*, the exact Greek dual of the word meaning "tripod." Jars with three, four, and no handles were also indicated pictographically following their correct Greek description, which was written syllabically. The Pylos tablet was, therefore, a virtual bilingual, in which words in the Greek language were translated into the universal language of pictures.



A two-syllable northwest Semitic word for "wine" is incised on this fragment of a large storage jar that was found at Knossos in northern Crete.

The Mycenaeans had inherited this scribal usage from the Minoans. Of the 154 Minoan administrative tablets that were discovered at Hagia Triada (a palace site located near the south coast of central Crete), one (called Text 31) was an inventory of vases and tripods indicated syllabically and pictorially, providing us with a virtual bilingual. One jar was labeled *su-pu*, another, *ka-ro-pa*, and a third, *su-pa-la*. These three words are well-known nouns for various pots in the Semitic languages, a closely knit speech family that includes Hebrew, Phoenician, Ugaritic, Aramaic, Arabic, Ethiopic, and Babylonian. In December, 1956, I noted that since three of the five legible pot names on Text 31 were Semitic, there was an even chance that the Minoan language was Semitic, and I also observed that numerical totals in the tablets that had been found at Hagia Triada were labelled *ku-lo*, which looked like the Semitic word *kull*, meaning "all."

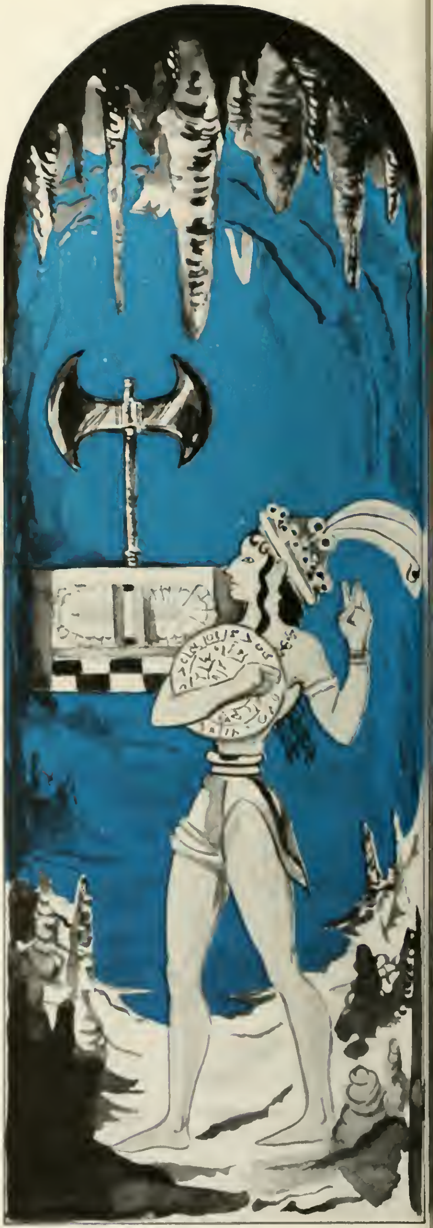
During the first five months of 1957, I scrutinized every Linear A tablet and fragment and concluded that the Minoan language was related to some Semitic dialect that was used on the Mediterranean shore of Semitic Asia. In the Minoan texts pairs of names are connected with the syllable *u*. That syllable could only stand for the conjunction "and." It happens that among the ancient Semitic languages *u* characterizes east Semitic, whereas in most of the familiar west Semitic languages the conjunction is *wa*. What no one realized at that time was that since remote antiquity *u* had also been used in west Semitic throughout the Mediterranean area. Another word that appeared to be east Semitic is *ku-ni-su*, designating a kind of wheat. This word was well known as *kunnishu*, "emmer wheat," in east Semitic inscriptions from Assyria. I was then not aware that it also occurred in the Aramaic branch of west Semitic as *kunneta*.

At this time, because the Minoan inscriptions had been found on Greek soil, they were considered to be a branch of Greek studies. Hellenists were glad to leave Semitics to the Semitists, who in turn were glad to leave the problems of Greece to the Hellenists. Few scholars suspected that prior to the fifteenth century B.C. all of the east Mediterranean islands and coasts were dominated by northwest Semitic sea lords, who were known to the ancient Hellenes as Phoenicians. Crete, and for that matter the coastal areas of peninsular Greece, belonged to northwest Semites before the Greeks began to take over. Semitic names occur in the Greek Linear B tablets, but Greek names do not occur in the earlier Linear A tablets. It is interesting to note that the Semitic names of Minoan individuals are exclusively west Semitic. The most familiar one of these Semitic names happens to be *da-we-da*, "David."

FROM the middle of 1957 to the end of 1961 progress in the decipherment of Minoan was woefully slow. The material at my disposal was limited in quantity and variety. Moreover, my view that the language was east rather than west Semitic impeded my progress, in that it caused me to retain some identifications that were wrong and to discard some of my earlier (and correct) identifications. In addition, the Linear A texts from Hagia Triada contained little besides proper names, numerals, commodity signs, and only a handful of other words, but there was nothing remotely related to sentence structure.

The only hope of finding sentences lay in eighteen inscribed cultic objects found at a variety of sites in eastern and central Crete. Unfortunately, I could do little with the first edition of these texts, which were published during World War II in Italy. In 1961, however, a new edition of the Minoan documents was published by W. C. Brice, of Manchester, England. Brice did not attempt to interpret the texts or to identify their language. Instead, he prepared a careful edition of the documents with new photographs and India ink copies. He also provided a list of the individual words in the original scripts. His work is objective and mechanical. The new photographs of the texts enabled scholars to see more than had been visible on the text reproductions in the earlier Italian edition. His India ink drawings enable the reader to perceive in the imperfectly preserved signs what Brice detected by a careful scrutiny of the originals. Moreover, although Brice did not try to pronounce a single sign (let alone interpret a single word), he isolated every word in the original script and compiled a useful index of words, adding the text references to each. Thus the reader can locate and study in Brice's book every occurrence of every Minoan word.

A four-syllable word in one of the religious texts had previously been read *x-re-x-tu*. Scholars had not been able to identify the first and third signs, which were only partially preserved. Brice's keen eye, however, observed that the traces of the first sign indicated *ki*, while the traces of the third sign unmistakably represented *ya*. Accordingly, the word was *ki-re-ya-tu*, a familiar west Semitic word meaning "city." As soon as I saw this, I realized that the language had to be west Semitic, because *ki-re-ya-tu* is found in Hebrew, Phoenician, Ugaritic, Aramaic, and even Arabic, but not in the east Semitic dialects usually called Assyrian and Babylonian. The entire inscription read *le*



Cultural links are reconstructed by the artist. Here Minos has just received the Law, divinely inspired by Zeus, in the sacred mountain cave.

ya-sa-[*sa-la-mu-* - - -] - - *ki-te-te-bi ki-re-ya-tu*, a perfect northwest Semitic dedicatory formula that means, "To the god Yashashalam so that the city may thrive." There was no longer doubt as to the classification of the Minoan language. It was northwest Semitic, of a type that the ancient Greeks would have called Phoenician.

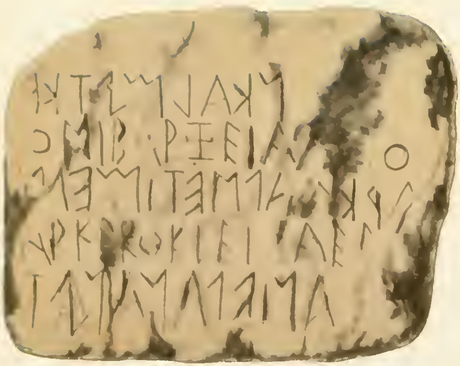
It developed that no fewer than six of the eighteen inscribed cultic objects were dedicated to Yashashalam, who was apparently the most popular god worshiped at the shrines, if not actually the head of the Minoan pantheon. His name means, "He who causes peace or well-being." He is still worshiped by the Mandeans, a dwindling sect in southern Iraq and Iran, who call him The Great Shishlam. He has therefore been worshiped from at least 2000 B.C. to the present day — longer than any other deity on record.

The other religious inscriptions confirmed the conclusions derived from the decipherment of the foregoing text. The verb *yatan*, "he gave," figures prominently in these dedications, precisely as in the dedicatory inscriptions of the later Phoenicians. We have at our disposal hundreds of votive texts in Phoenician and Punic (as Carthaginian Phoenician is called). The Phoenicians set up colonies all over the Mediterranean shores, in Asia, Europe, and the islands. Their texts give us the collateral information we need for interpreting the earlier Minoan texts, which were written by the predecessors of the later Phoenicians in an earlier stage of essentially the same language. In other words, the Minoans and later Phoenicians have left us votive offerings not only inscribed with the formula "he gave" or "he donated," but in the same language, with the same words pronounced in the same way.

At this juncture we might observe some of the methods inherent in decipherment. The first is known as the method of the "probable word." The word *ki-re-ya-tu*, "city," is "probable" because cultic centers were located in towns, and members of the community gave gifts to the gods for the welfare of the town. Today we are accustomed to think in terms of either mankind, nation, or sect. People in the ancient Mediterranean thought rather in terms of their city, state, or local shrine. The verb "to give" is probable because offerings to the gods had to be given. Now the verb *yatan*, which is of high frequency in the Minoan dedications, is also of high frequency in the extensive corpus of Phoenician dedications. The method of "frequency" is also a factor in deciphering. To find a problematic *rarity* of the Phoenician texts in the Minoan texts might shed more obscurity than light. When, however, a common feature of the Phoenician dedications is also common in the Minoan dedications, frequency puts the Phoenician-Minoan equation on a firm footing. Yet another procedure inherent in our method is the use of collateral information. Fortunately, the northwest Semitic world provides us with a vast array of administrative and religious documents that give background for interpreting the Minoan inscriptions. Collateral information enables us to understand ancient situations and how they were expressed. Thus, the Phoenician texts provide us with the actual phraseology of religious dedications, so we do not

Kook!

The description in Genesis of Moses receiving the divinely inspired Law from Yahweh on the holy Mount Sinai is startlingly similar in its concept.



Funerary stela found at Praisos, Crete, invokes kindness from "whoever he be, lord of a fortress or any man at all." On this tablet the writing alternates in its direction from line to line.

have to resort to speculation and guesswork when we meet the same phraseology in the Minoan dedications.

The Linear A texts found at Knossos are also Semitic. A spiral inscription in ink on the inside of a bowl begins with the word *a-ga-nu*, a well-known Semitic word for "bowl." A huge jar suitable for storing wine is incised with an inscription including the two-syllable word *ya-ne* = *yain*, the northwest Semitic word for "wine."

In Minoan times, Knossos may well have been the chief palace city of the entire northwest Semitic sphere. The evidence ties in with the ancient Greek traditions of Knossos. According to the *Iliad*, the leader of the Knossos contingent was Idomeneus. The stem of his name, *Idomen-*, is reminiscent of the Semitic *Admoni* ("ruddy," as applied to Esau and David): the root is the same as in *adamah*, the Hebrew word for "earth," which is reddish brown. His second in command was Meriones, which seems to be the same as *maryann-*, used as a proper name at Ugarit, even though the word is of Indo-European derivation and means "charioteer." King Minos, who ruled at Knossos, was the son of a Phoenician princess, Europa, according to ancient Greek tradition. His name, borne by a citizen of Ugarit, is written alphabetically at Ugarit as *Mn*. His master craftsman, Daedalus, has the name of another citizen of Ugarit: *Ddl*. The prominence of bull-vaulting on Minoan Crete recalls the bull-grappling in the most ancient art and literature of Mesopotamia and in the identification of the Ugaritic god El with the bull. The minotaur of Knossos — part bull and part man—ties in with monsters in Ugaritic literature that are also part bull and part man. In other words, we are confronted not with isolated parallels at Knossos, but with a whole galaxy of interlocking parallels, associating Knossos and its Minoan civilization with the Semitic world, and involving language, tradition, sport, religion, art, and personal names. In cultural parallels, individual points may be haphazard, but a whole complex of commo features — such as those that link Knossos with Semiti Asia — cannot be accidental.

The old Hellenic traditions leave no doubt as to the rol the Phoenicians played in Greece during the second millennium. The Phoenician Cadmos, who was Europa's brothe conquered Thebes and introduced the art of writing. It i generally thought that the Cadmaean letters refer to th Phoenician alphabet. The fact that Cadmos belongs to th Heroic Age, however, suggests rather that the script h introduced was Linear A. This was well into the secon millennium — long before the alphabet was used in Greec but when the use of Linear A was at its height.

There are many other Greek traditions concerning th Old Phoenician penetration of Greece. For instanc Danaos, a Phoenician, conquered southern Greece, and fo a long time thereafter his Greek successors referred t themselves as Danaoi. According to tradition, anothe Phoenician, Kilix, conquered Cilicia, where Phoenicia continued to be used as a written language until late in th eighth century B.C. In the second century B.C., the Spartans interpreted their ancient connections with the Semite as establishing a kinship between Spartans (or Lacedemonians) and Jews (First Maccabees 12:21).

Long before the Linear A and B tablets were discovere individual scholars had realized the importance of th Phoenicians in ancient Hellas. Victor Bérard, a Frenc classicist writing toward the close of the nineteenth centur and during the first third of this century, fully appreciate their role. Although he did not know enough of Semiti linguistics to handle the Phoenician material with professional skill, he was far ahead of his time as a historia However, the scholarly world of the late nineteenth an early twentieth centuries was geared to a compartmen alized approach, and it was thought that the Semites an

Numerals "seven," "nine," and "ten" appeared on this second funerary stela, also discovered at Praisos. In addition, the stela refers to "that rule of Praisos," and includes other Semitic phrases.

Greeks had nothing to do with each other in pre-Hellenistic times. Bérard was shouted down and discredited so violently that "respectable" scholars feared to cite him.

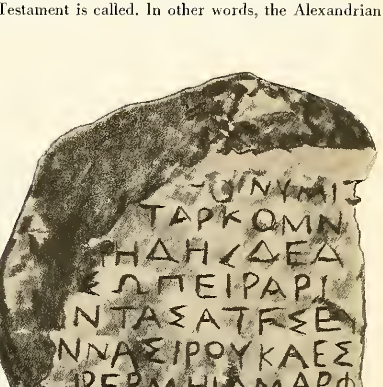
Franz Dornseiff, a German classicist who flourished during the first half of this century, demonstrated that Hebrews and Greeks never completely lost touch with each other after 1000 B.C. Dornseiff was treated with more respect than Bérard, but nonetheless his work was generally disregarded. In 1940, the French Egyptologist Raymond Weill published an important book in which he maintained that prior to 1500 B.C. the entire east Mediterranean was dominated by one and the same Phoenician culture. His work, too, had no effect on the mainstream of scholarship.

In January, 1962, I wrote my first article to show that the language of the Minoan texts was northwest Semitic, of a type that might be called Phoenician. Confirmation came suddenly from an unexpected source. A South African scholar, Professor S. Davis, head of the Classics Department at the University of the Witwatersrand in Johannesburg, had just published his interpretation of four Cretan texts (three from Praisos and one from Psychro) in Greek characters dating from between 600 and 300 B.C. All four documents were written in the pre-Greek language of Crete, which scholars called Eteocretan and equated with the last stage of the Minoan language, which had flourished over 1,000 years earlier. It did not occur to Davis that these texts might be Semitic, but now that I knew what to look for, I appproached the Eteocretan texts as northwest Semitic. Whole phrases, including appropriate formulas (paralleled in comparable Semitic stone inscriptions) up to ten words long, turned out to be northwest Semitic of a type that any student of Hebrew should be able to understand. The three texts from Praisos all had *mit* in the first line, suggesting that they were funerary texts, for *mit* means "died" in Semitic. The texts make appeals to the passer-by, whoever he might be, to treat the memory of the dead with respect. The passers-by are once addressed as *nas iro u kl es*, "the people of his city or any other man." In another text an appeal is made: *et me u mar krk o kl es u es*, "with whoever he be, lord of a fortress or any man at all." The Phoenician numerals for "seven," "nine," "ten," and other parts of speech emerged quickly and clearly from the Eteocretan text.

The most unexpected development came to the fore in October, 1962. A Greco-Eteocretan bilingual had been found at Dreros, Crete, and published in a French journal in 1946. During the years that followed, classicists discussed the text, but were unable to do anything with the Eteocretan version, for they never asked the qustion: could Eteocretan be Semitic? The Dreros bilingual was a dedication to someone's mother. The last word in the Eteocretan part was *lmo*, meaning "to his mother" in northwest Semitic, and corresponding to [*tai*] *matri tai a*[*utou*] at the end of the Greek version. There could no longer be any doubt that the pre-Greek language of Crete was northwest Semitic. This "Rosetta stone" came to my attention too late to be of any help in starting the decipherment of Minoan, but it provided a convincing reconfirmation of the solution of the Minoan problem and, of course, offered new material for the comprehensive study of Minoan.

To recapitulate: Minoan Linear A was deciphered without any help from its Eteocretan descendant. The Eteocretan texts subsequently confirmed the northwest Semitic character of the pre-Greek Cretan language. Finally, a Dreros bilingual gave us the same text in Eteocretan and Greek versions, so that the Greek reconfirmed the decipherment by assuring us that our interpretations of the northwest Semitic readings were correct.

The end was not yet. Professor William McDonald of the University of Minnesota sent me, early in 1963, a reprint of an inscription he had published in 1956 — another bilingual from Dreros, this one having to do with absolution from oaths. The Greek version ended with *katheron genoito*, meaning "let there be purity." The Eteocretan version reads *tuhr maher ihia*, meaning "purity quickly there shall be." In the familiar pronunciation of Hebrew, the phrase would appear as *tohar maher yihye*. The last word in the Eteocretan version is of the greatest interest, because it reflects the pronunciation of Hebrew as used in the Septuagint, as the ancient Greek translation of the Old Testament is called. In other words, the Alexandrian



Deceased who "fell asleep and died," here demands kind treatment from "the people of his city or any other man" on pain of exile. All three texts include the word "mit," a Semitic word for died.

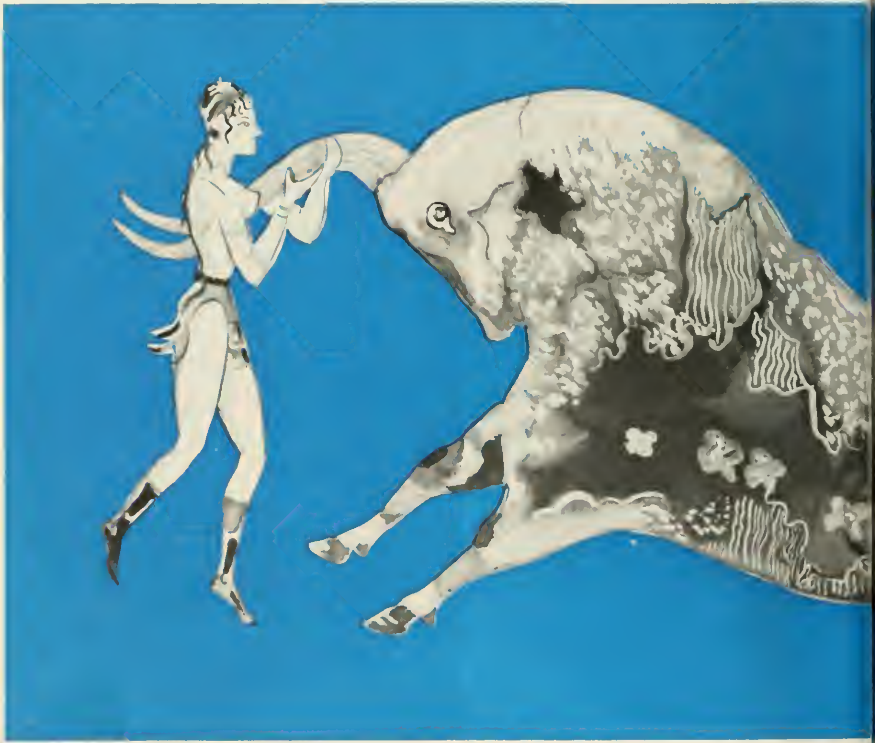
translators of the Septuagint, understandably enough, pronounced Hebrew in accordance with the Mediterranean pronunciation, as used by the Eteocretans. Thus, *yi-* in standard Hebrew corresponds to *i-* in Eteocretan, as in names like "Yisrael," which comes into English, via the Septuagint, as "Israel."

The implications of the northwest Semitic character of the Minoans are far-reaching. We are now confronted with the incontrovertible fact that the civilization of Greece was Semitic before it became Greek. To state the matter differently, Mycenaean civilization was essentially the Semitic Minoan civilization, which was subsequently taken over and transformed by the Greeks.

The origins of Greek civilization, Hebrew civilization, and the early history of Europe will have to be revised, re-evaluated, and rewritten. No longer can we regard Western culture as the result of a combination of two alien components. Rather, the Hebrews and the Greeks originated and flourished together during the same centuries and in the same rather restricted area of the east Mediterranean, where they were never totally cut off from each other. It is now clear that the two peoples, although speaking different languages, were heirs of the same general civilization that spanned the entire Mediterranean from Palestine to Greece throughout the first half of the second millennium B.C.

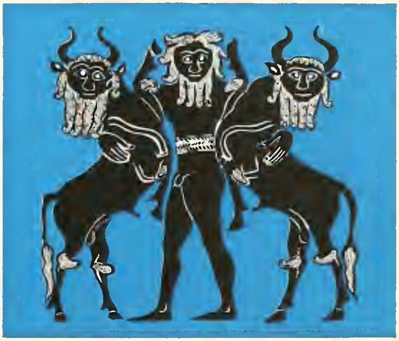
For the rest of the second millennium, the Hebrews and Greeks resembled each other more than they did their own classical descendants. Thus, we find the Greek Agamemnon sacrificing his daughter for the sake of his expedition, even as the Hebrew Judge Jephthah sacrificed his daughter for the same reason (Judges 11:30-40). We read about Abraham recovering his wife from the palaces of other kings (Genesis 12:15-20; 20:2-16), even as Menelaus retrieved his wife, Helen, from the palace of Priam. Samson went into a rage because a woman had been taken from him, nor was his wrath appeased until many innocent men had died (Judges 15:1-8). Achilles caused a similar catastrophe for the same reason.

During the first millennium, the Greeks and Hebrews worked out their own individual destinies, giving the world their distinctive contributions. The Hebrews produced the great literary prophets with their messages of social perfection, demanded by their concept of the nature of God. Meanwhile, the Greeks produced their peerless scientists,

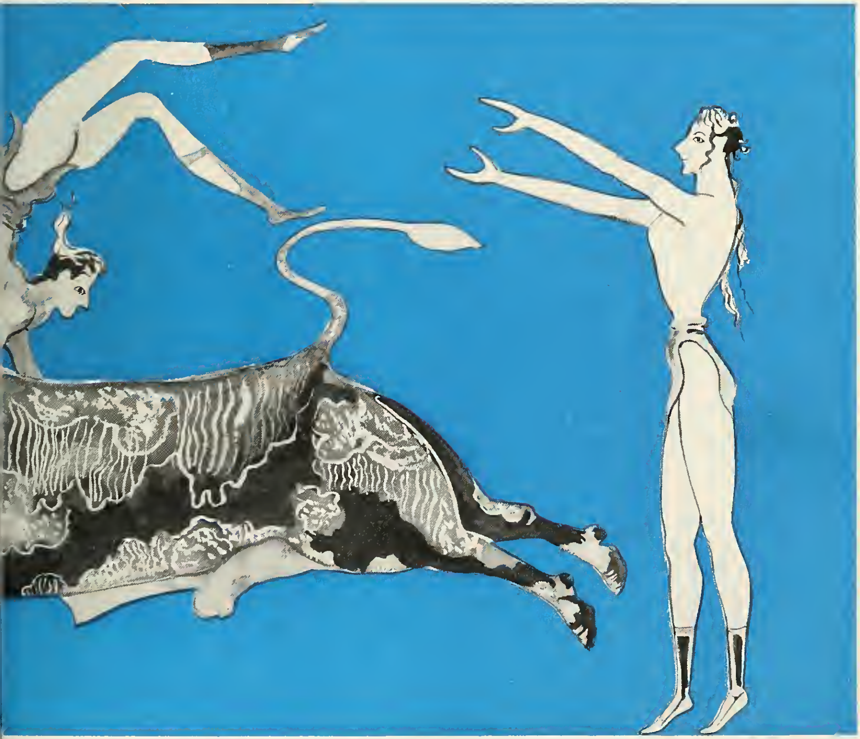


philosophers, and artists. The Age of Pericles is radically different from the contemporaneous age of Ezra and Nehemiah. But Achilles was not a Greek philosopher, nor was Samson a Hebrew prophet. Scholars have been all too prone to assume from the classical periods of Israel and Greece that the two fountainheads of Western civilization were always poles apart, but it follows from the discussion above that early Greek and Hebrew literatures now provide us with valuable commentaries on each other. Minoan studies have bridged the gap between primeval Hellas and nascent Israel. No longer need we be perplexed by early narratives in Scripture such as the one in Genesis 6:1-4 about deities that mated with women and sired heroes out of them. To be sure, this sounds more like an epic of Homer than the Bible, but once we realize that Greece and Israel are parallel structures built upon the same east Mediterranean foundation, our perplexity gives way to understanding.

The total significance of this new development will require the combined efforts of a whole generation of scholars. We can discern the outline, but the full story is unwritten. Its relevance will not be lost on those who understand that we can never know ourselves until we have fathomed the origins and character of our own civilization.



Bull cults were common in this area. Gilgamesh, a Mesopotamian hero, grapples with bulls, above. Minoan frescoes portray boys and girls vaulting over charging bulls, below. Israel reverted to a branch of the cult in its Golden Calf worship.



Archipelagic Refuge

Endemic floras abound in Hawaiian chain

By Benjamin Stone

In the Hawaiian Islands today there are large numbers of plant genera and species that once must certainly have been extant in some other areas of the Pacific, but that cannot be found anywhere else in the world at the present time. In a sense the great Hawaiian Archipelago might be said to have become, over many centuries, a final haven, an accidental nature museum for the otherwise extinct plant populations of an earlier geologic time. To a large extent, this unique character of the Hawaiian flora may be the result of the chain's geography, and any attempt by botanists to piece together the origins of present-day Hawaiian plants must at some point take into account the archipelago's position.

Although the Hawaiian Islands (the Sandwiches) may be said to have been at a human crossroads from as early as the Polynesian migrations, in terms of movement within nature the islands have probably long existed in almost total remoteness. Today, the Hawaiian Archipelago is more isolated than any other island group of comparable size in the world. Eight of the islands are familiar to almost everyone. Of these, Kauai, Oahu, Molokai, Lanai, Maui, and Hawaii are the major islands; Niihau and Kahoolawe are smaller.

And there are still others. Northwest of Kauai, in a roughly linear pattern, stretches a series of reefs, shoals, islets, and atolls, terminating in Kure Island atoll and Midway Island, more than one thousand miles from Kauai. These fragments of land include (from northwest to southeast) Pearl and Hermes Reef, Lisianski and Laysan Islands, Gardner Pinnacle, La Perouse Pinnacle, French Frigate Shoal, and Necker and Nihoa Islands. Near the island of Kauai, the two small rocks Lehua and Kaula rise from the ocean, and Molokini Island arcs between the larger formations of Maui and Lanai like a new moon.

The geology of the Hawaiian Islands is fairly straightforward: an island-building process by submarine volcanoes proceeded sequentially from northwest to southeast. Midway and Kure are the oldest remnants of this great archipelago's northwesternmost points. The still-active volcanoes—"drive-in volcanoes," as the Hawaii Visitors Bureau calls them—are on the island of Hawaii, southeasternmost member of the group. Of the two great peaks on Hawaii, Mauna Kea is the more rugged, with numerous auxiliary cones, but Mauna Loa is truly immense. Both mountains rise more than thirteen thousand feet above the ocean. In volume, Mauna Loa could easily contain ten peaks equal in size to Mount Rainier or Mount Hood. Next in height is Haleakala—the world's largest extinct crater--on Maui, adjacent to Hawaii to the northwest.

Altitudes elsewhere in the islands do not exceed six thousand feet. Thus, the evidence from erosion indicates increasing island age as one moves to the northwest. Kauai is the oldest of the islands that make up the "big eight," although a few of the smaller islands are probably older. Laysan, Lisianski, and the other fragments northwest of Kauai have only coral reefs left to indicate the subsidence, or the wearing away and final disappearance, of what once might have been islands larger than any of those existing today.

Screw pines, *Pandanus tectorius*, were called halas by the Polynesians. They grow on Pacific islands east to Hawaii.

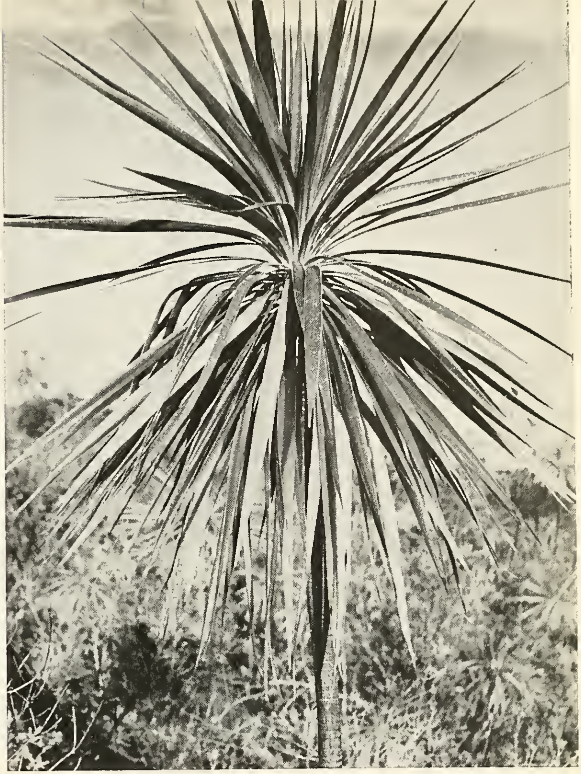
Such, then, is the floras' setting. Native Hawaiian botany began with the Polynesians who settled in the islands. They named crops and timber trees, plus many other plant species that were never cultivated, except perhaps for magical uses. In many cases, the Polynesians used a binomial system of plant identification, which sometimes corresponds rather closely to modern scientific classification. For instance, their word ohia, in conjunction with a modifying word, was applied to trees of the family Myrtaceae (the myrtle family), their ohia lehua being our *Metrosideros collina,* their ohia 'ai our *Eugenia malaccensis,* and so on.

For the European world of science, however, the solution of the puzzle implicit in Hawaiian botany began with the voyages of Captain James Cook, and the earliest European plant collections were those of David Nelson (who later perished in Timor after accompanying Captain Bligh, along with seventeen other loyal crewmen, on the amazing open-boat journey following the mutiny on the *Bounty*). Thus, there were certain Hawaiian plant specimens in Europe before the year 1800, but a Hawaiian gooseberry, the ohelo, or *Vaccinium calycinum,* collected by Archibald Menzies in 1803, was probably the first Hawaiian plant to be described (by the English botanist J. E. Smith in 1819). From then on, collections and publications accumulated, with Chamisso, Gaudichaud, and many others traveling to the islands and sending specimens to Europe.

But Hawaiian botany became truly comprehensive only with the publication of Hillebrand's classic *Flora of the Hawaiian Islands* in 1888, in which the author accounted for about 1,000 species of flowering plants and ferns. Significantly, Hillebrand's work was the first to indicate that there were large numbers of plants peculiar to the Hawaiian Islands. In proportion to its total native flora, the archipelago seemed to have more unique species than any other similar area in the world. Hillebrand's estimate of specific endemism was 75.93 per cent. (Of the approximately 1,000 species Hillebrand classified, 115 were identified as introduced species and were therefore discounted: of the remaining 860 native species, 653 were endemic.)

Subsequent study has increased the number of known native and introduced species to about twice as many

HEALTHY SPECIMEN of *Pritchardia eriophora* from Kokee area of Kauai appears below. It is only endemic palm that still thrives in the islands.



Composite, *Wilkesia gymnoxiphium, right,* is related to sunflower and daisy.

as were known to Hillebrand. Fosberg, in a very interesting article on the derivation of the Hawaiian flora, has calculated that 1,729 species and varieties in 216 genera actually make up the islands' flowering plant flora. These, added to 168 species and varieties of ferns in 37 genera give a total of 1,897 species and varieties in 253 genera. However, his total does not include the mosses or liverworts, the lichens, fungi, or algae, of which there are also numerous endemic species.

A compromise figure would indicate that perhaps nine out of every ten Hawaiian species will be found nowhere else in the world. Within the archipelago itself, many species may live on but a single island of the chain, sometimes only in particular mountain ranges or in particular valleys within these ranges, in certain swamps or on certain peaks. Even among the alpine floras of the highest summits, endemism remains around 90 per cent. This suggests that the present Hawaiian high-altitude flora probably originated on other Pacific islands that today lack alpine habitats because of centuries of erosion.

When we turn to genera, the story is similar to that of species, although the percentage of endemism is, of course, much lower. There are about forty-two endemic Hawaiian genera. Two are red algae (Rhodophyceae) that may still be found elsewhere in the Pacific after further exploration; another is a moss (the genus *Baldwinella*), while three others are ferns. Still another is a monocotyledon (the grass *Dissochondrus*). The remainder are dicotyledons. There appear to be no indigenous lichen genera; while I have not attempted to calculate the number of species and genera of fungi, perhaps a certain number of the latter are also confined to the islands. Although there are no endemic families, some of the genera are unusually distinctive. To quote one authority, the relationships of certain genera are "so cryptic that no one has yet been able to discover anything closely allied to them outside of Hawaii."

Although many botanists have made important contributions to the islands' plant taxonomy, there are still any number of problems that must be solved before a completely accurate catalogue of Hawaiian plants can be prepared. However, the broad outlines of a pattern appear to be sketched in with some accuracy, so that today it is possible to consider Hawaiian genera from a geobotanical standpoint.

One may ask from what regions of the earth the immigrant plants first came. Among contemporary botanists, both Skottsberg and Fosberg have studied this problem and have arrived at similar conclusions. According to Fosberg, one need postulate only 272 original immigrants to account for the present number of flowering plant species in the archipelago. Of these, about 40 per cent would once have been natives of the Indo-Pacific region, and 16.5 per cent would have been of boreal, pantropic, or obscure origins. Among the ferns, 135 original immigrants have been postulated, with nearly half of them Indo-Pacific in derivation, some 12 per cent American, and 3.7 per cent Austral; the rest were boreal, pantropic, or obscure.

Roughly half of the archipelago's present total vascular plant flora would thus seem to have derived from the pre-existing flora of the Indo-Pacific region, while perhaps 16 per cent would have American origins. Fosberg has shown that of the plants of American origin, more than half have continued living with no significant changes since their arrival on the islands; the other portion includes nineteen species clearly related to known American species, and ten of unclear affinities. It seems probable that the American element in the Hawaiian flora is of rather recent vintage. This corresponds with the fact that the island-building process proceeded in the direction of the American continent. It should be noted that the floral pattern is in marked contrast with the zoogeographic position of the Hawaiian Islands from the standpoint of ornithology. Ernst Mayr, writing in *The Condor* in 1943, stated: "It is self-evident . . . that the Hawaiian avifauna shows an overwhelming preponderance of North American, that is, Holarctic, elements." But the origins of the rest of the island group's fauna, insects, arachnids, and molluscans fit the picture drawn from vegetation.

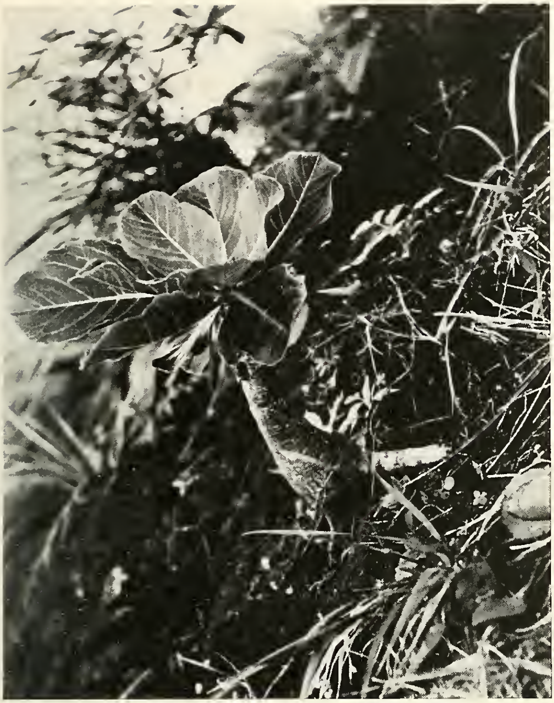
In the evidence that has gone into this general plant-geographical profile, there are still many ambiguities. Just as Darwin's visit to the Galápagos Islands on the voyage of the *Beagle* provided him with a living example of adaptive radiation, a contemporary biologist's sojourn in the Hawaiian Islands would furnish rich materials for a similar study of evolutionary divergence. In both cases, the results of adaptation to a special environment are manifested in the unique forms of species endemic to the locales. But another result is also observable—a high incidence of extinction.

Among Hawaiian birds, for instance, most species of honeycreepers (family Drepanididae) and Hawaiian thrushes (genus *Phaeornis*) are thought to have become extinct. Despite the recent rediscovery of the Kauai o'o bird (*Moho braccatus*, family Meliphagidae, or honeysuckers), it seems clear that most of the endemic Hawaiian land birds have succumbed to events stemming from man's disturbance of nature. Alteration of habitat because of a multitude of changes, directly or indirectly brought about by the increasing human population and its activities, affected first those organisms that were most delicately adjusted to the environment—those that were at once among the most interesting, yet most vulnerable, of the Hawaiian biota. *Pelea sandwicensis*, a plant, and the Laysan honeycreeper, *Himatione sanguinea freethii*, a bird, were typical of those to die off.

Extinction of plant species has also occurred. The well-known modern Hawaiian botanist St. John has remarked that studies of the Hawaiian flora must include something resembling paleobotany—not so much in the sense of studying fossils as in realizing that species in certain genera are now represented only by museum specimens. Such is the case, for example, of the genus *Gouania*, in which several species are represented by only a few specimens collected by Jules Remy a century ago and preserved in the Paris Natural History Museum. Other examples may be found in the genus *Pritchardia*, the loulu palm, which once occurred on Laysan Island but is now known there only from hearsay and a poor photograph; again, the Molokai tree cotton, *Kokia cookei*, is extinct in nature but is still preserved in the form of a few cultivated individuals. The strange forest giants discovered in 1913, which have been described as the endemic genus *Neowawraea* (but which perhaps are really *Drypetes*), are represented by only a few individual trees.

Silversword looks like species of cactus, but instead is a rare tree.

The phenomenon of extinction is of great interest to the student of evolution and is responsible for the grayest area remaining in the evidence collected by Hawaiian botanists. There are several kinds of extinction. Even though a species ceases to exist, it may still have contributed to the gene content of a related and continuing species, and the resulting phenomenon may be called "divergence." For instance, a given species may gradually differentiate into two slightly differing forms, and over a period of time the



Cliff-hanging *Brighamia insignis* was compared to a "cabbage growing on a post" by Hillebrand; the shrub below is in the family Saxifragaceae.

intermediate types may disappear. The result is the formation of two "new" species, and the disappearance of the "old" one. But if every individual dies without progeny, the term "extinction" applies and carries a different meaning. It is the latter connotation that seems to apply most widely in a consideration of extinction in the Hawaiian flora and fauna. Sometimes the evidence of this is manifestly clear.

In 1919, Joseph Rock, one of the pioneers of twentieth-century Pacific botany and an explorer of continental Asia, disclosed the melancholy appearance of the last *Kokia* trees on Molokai, at a time, it is true, when goats, cattle, deer, and humans had invaded the islands. Rock wrote:

"In April, 1910, the writer found a single tree (of *Kokia cookei*, then called *K. drynarioides*) in a lonely, dry canyon at the extreme west end of Molokai back of Mahana. It was a small, stunted tree about 10 feet in height. Although it was full of fruit and leaves, it showed signs of decay, so that the passing of a year or so would find the species extinct.

"In June, 1915, the writer made another visit to the then only living tree. . . . It was nearly dead, only one or two branches still bearing foliage. There were neither flowers nor fruit on the tree. A search on the ground rewarded the writer with a few seeds, some of which were grown in Honolulu. . . . Unfortunately, [these] seedlings . . . died on account of the excessive rains during the winter. . . .

"While on Molokai in 1918, the writer visited the tree again, but it had died; only the worm-eaten, barkless trunk, and branches, remained of the last of its race."

From Rock's account, it seems possible, at least, that the Molokai tree cotton had become extinct because of natural circumstances that may have been operative prior to the coming of the European and perhaps to the Hawaiian population of the islands. To what extent these circumstances were supplemented by more recent human activities is unclear, although disturbance of the habitat, whether by agriculture or by deliberate or accidental introduction of exotic species, is assuredly the major factor operative in the extinction process today.

Mauna Kea, Hawaii, may be considered from this standpoint. The hordes of introduced sheep living in a feral state on this mountain have caused an immense amount of damage – first, to the vegetation through overgrazing, and second, as an inevitable result, to the soil. The island of Kahoolawe, now essentially bare rock, was once forested. Lanai, were it not for the intelligent planning of an influential plantation manager, George Munro, might have become another barren Kahoolawe.

REFORESTATION projects, such as those urged by planting programmers, concentrate on introducing species that, in addition to their qualifications for successful growth in a given area, also yield useful products, the most obvious being timber. To this end such species as eucalyptus, ashes (*Fraxinus*), paperbarks (*Melaleuca*), Norfolk pines (*Araucaria*), lodgepole pines, redwoods, and others have been planted in many locations in Hawaii. Some species have been eminently successful in the new habitat; others have not. Most of these introduced species, it is true, have been planted in disturbed areas at relatively low elevation. But recently plantings have often required the removal of native trees.

One further danger implicit in reforestation is the establishment of aggressive exotic species. In Hawaii, as for that matter in most countries of the world, the introduced portion of flora in the total population is rather large. Much of this adulteration was accomplished even before the middle of the nineteenth century, and such plants as lantana, haole-koa (*Leucaena*), guava, cactus, and blackberries are now so common as to be nearly ubiquitous. Some species, such as the Philippine ground orchid (*Spathoglottis plicata*), are not only apparently harmless to native flora, but are rather attractive. But *Rubus penetrans* and the thimbleberry, *Rubus rosaefolius*, crowd out native species. Although the populations of encroaching lantana have dwindled in many locations because of an intensive biological control program utilizing gall-forming insects, hundreds of other weedy species now pose actual or potential threats to endemic species.

Whatever the success or failure of conservation programs, contemporary botantists can still examine a Hawaii that is, at least in part, like the one Polynesians might first have seen. On Oahu, there is a well-known hill behind the city of Honolulu called Mount Tantalus. Nearby are the summits Olympus and Round-Top and, farther inland, impressive Konahuanui, which is frequently hidden by low clouds (its elevation is about three thousand feet). Manoa Cliff Trail, which starts from Round-Top and winds westward toward Tantalus, connects by another trail to Konahuanui. This is famous botanical ground: here trod the explorers of Captain Charles Wilkes' United States Exploring Expedition of 1838-42: Gaudichaud was here as was Horace Mann, Jr.; William Brigham and Amos A. Heller botanized these ridges. Endemic species abound in numerous genera, such as *Scaevola, Cyanea, Bobea, Metrosideros, Clermontia.* If one ascends Konahuanui and is prepared to take a certain amount of risk, such as lowering oneself over a ridge above a thousand-foot drop, one can catch a glimpse of the magnificent 'apeape, or *Gunnera*, with umbrella-like leaves—a plant with distant cousins in Chile and New Zealand.

Equally fertile botanical ground exists on Oahu. Castle Trail, in Punalu'u, zigzags and loops up and up to the summit of the Koolau Range, then crosses the summit trail and drops down to the Kaluanui Stream. In every direction superb panoramas unfold: the long and steep ridges of the Koolau Range surround valleys in which the powdery, green-white color of *kukui* tree forests (*Aleurites*) stands out. As one crosses the summit trail, sheltered valleys may be seen in which are scattered loulu palms (*Pritchardia*), tree ferns (*Cibotium*), ohias, and other native shrubs and trees in profusion. Along the pools of the Kaluanui grows a botanical prize—a tree lobelia, genus *Trematolobelia*, with masses of pink flowers. Cyrtandras—Hawaiian cousins of the African violets that attain the size of shrubs or small trees—are numerous, and their flowers are almost invariably pure white. A hundred different species of *Cyrtandra* may be found today on Oahu alone.

NO more striking contrast to these areas could be found than the arid, lava-covered deserts of Maui and Hawaii. In general, the older the lava flow, the denser its vegetation. Some areas are so old that the lava has broken down into soil; here, as in the famous "Bird Park" (Kipuka Puaulu) of Hawaii National Park, can be found some dozen of the largest and rarest trees in the archipelago. These include *Pelea zahlbruckneri*, *Pelea hawaiiensis* var. *Gaudichaudii* and *Straussia hillebrandii*. In this "island," or kipuka, surrounded by lava flows of rather recent vintage, chance has permitted the survival of a fragment of forest in which more than forty different floral species occur, all endemic to Hawaii, and several to this enclave.

Around the vast and desolate crater of Haleakala, the modern botanist can successfully seek out the famous silverswords, *Argyroxiphium sandwicense*. The rosette of swordlike leaves and the thick, erect shoot with its thousands of flowers brings to mind a yucca, but there is only the faintest of botanical relationships. Rather, the true cousins of the silversword are California's daisy-like tarweeds. A less known relative, the greensword (*Argyroxiphium virescens*), may be found in the summit swamps of west Maui.

ONE of the intangible elements of a trip into the Hawaiian forest is a feeling of remoteness. When no town is in view, and one sees nothing but the forest and the sea, and thinks of the thousands of miles of ocean stretching away in every direction, then this sense of isolation is strong. The botanist's puzzle then becomes almost spiritual in its force. How, one asks oneself, did Hawaii's myriad plants and animals arrive? The distances seem staggering. And for the Polynesians in their sailing canoes, voyaging from Tahiti or the Marquesas, navigating by the sun and stars, to have come and returned and come again—this, too, seems almost unimaginable. Yet the floras are here. If only because the floral evidence has not yet all been collected and reconstructed the record must be preserved in order that a solution may one day be found.

Carl Skottsberg, the Swedish naturalist, who knows and loves Hawaii and its plants, has spoken eloquently of man's responsibility to these islands: "No child," emphasized Skottsberg in 1939 in the proceedings of the Sixth Pacific Science Congress, "should leave school ignorant of the fact that the Hawaiian Islands are looked upon by all the outside world as the most important refuge for the original living world in Polynesia, that it is full of problems unsolved, that we are the managers of a property the value of which cannot be expressed in figures, belonging to all mankind. . . ." This verity, of course, the botanist knows.

Fruiting branches of *Tetraplasandra hawaiiensis* were collected in Hawaii National Park. Species is in ginseng family of shrubs, vines, and trees.

Skyward view of a large *Tetraplasandra,* or 'ohe, is shown below. Many more endemic members of the family Araliaceae thrive in the island chain.

SKY REPORTER

Meteorites are unique source of extraterrestrial substances

SIMONE DARO GOSSNER

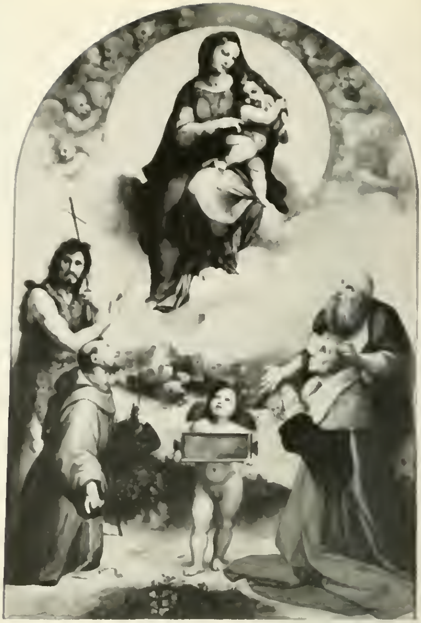
THE FLASHING OF A METEOR TRAIL across the sky is such a familiar sight that it has become part of our folklore and of our superstitions. Youngsters wish upon the "falling star," and in some parts of the world old people cross themselves when they see one. But in the world of science such an event is insignificant—no more than a speck of matter from interplanetary space heated to incandescence and eventually vaporized by friction with the earth's atmosphere. Statistics have shown that at least 90 per cent of these specks stem from the disintegration of comets.

Not to be confused with meteors are the meteorites, or "stones from heaven" as they were called in past centuries. Whereas meteors are fully consumed during their fiery trip through the atmosphere, meteorites are larger chunks, fragments of which strike the earth's surface. The biggest ones, called fireballs, often explode in mid-air.

It has been estimated that some 350,000 meteorites, most of them of small size, pelt the earth during one century. An average of twenty-five meteorites per year reach ground in the United States. Owing to the vast area over which the falls are distributed, the odds are, fortunately, much against anyone being struck by a meteorite. In the past four and a half centuries, only fifteen cases have been recorded involving a direct hit on a person or a domestic animal. In none of these cases, except perhaps the most recent one (Alabama, 1951) could it be fully ascertained that the stone was actually of extraterrestrial origin.

There have been, however, a few spectacular near misses. One of these was commemorated in the "Madonna di Foligno" by Raphael (*reproduced above*). Early in the sixteenth century (*ca.* 1512) a meteorite fell on the house of the Conti family in Foligno, Italy. The stone did little damage and hurt no one. Sigismondo Conti, a papal secretary at the time, commissioned the painting as a votive offering. It has been argued recently that the Conti house may have been hit by a ball of lightning rather than a meteorite, but contemporary records of a "shower of stones from heaven" in the general vicinity of Foligno lend credence to the traditional interpretation of the painting. The falling meteorite (*detail, right*) was incorporated in the composition—probably the only classical painting of such an event depicted from an eyewitness account.

The astronomical interest in meteorites is prompted by the fact that they are as yet the only extraterrestrial substances available for analysis in the laboratory. They are classified generally into two broad categories: stony ones containing silicates of iron, magnesium, calcium, aluminum, and traces of other substances; and metallic ones containing alloys of iron, nickel, and occasionally cobalt.



Some specimens, found in lesser numbers, exhibit a mixture of both the stony and metallic compositions.

When a meteorite penetrates the earth's atmosphere, the enormous amount of heat generated by friction (as in the re-entry of a space capsule) causes a fusion of the outer layers. The meteorite may explode with a noise like thunder, and its fragments may scatter over several square miles. The heavier pieces occasionally bury themselves in the earth with great violence, but usually most of the fragments are small enough to be cushioned in their fall by the surrounding air and thus make a relatively soft landing.

At the other extreme of the size scale are micrometeorites—particles so small that they can travel without harm through the atmosphere and float to the ground. Smaller than grains of sand, they are nevertheless so numerous that the total amount of micrometeorites falling on the earth has been estimated at two million tons per year.

WHEREAS shooting stars are mostly the debris of comets, meteorites are believed to be related to the asteroids, the countless small planets of the solar system. The first one of these was discovered by the Italian astronomer Giuseppe Piazzi on January 1, 1801. Before then, astronomers had noted a seeming gap in the arrangement of planets at increasing distances from the sun. If there were an orderly progression to this arrangement, a planet was missing somewhere between Mars and Jupiter, at about three times the distance of the earth from the sun. Piazzi's new object—later named Ceres—was indeed at the required distance, but its size was disappointingly small.

If the discovery of Ceres restored a semblance of order to the solar system, the satisfaction experienced by Piazzi's contemporaries was of only brief duration. Juno, Pallas, and Vesta followed Ceres within a few years. By mid-century dozens of asteroids had been found. Once celestial photography entered the scene, the tempo of discoveries increased beyond all estimates. Now over two thousand asteroids are catalogued and so many more are on Palomar photographs that observers have stopped counting.

Ceres turned out to be the largest asteroid of all, with a diameter of 480 miles. The others range in size down to a one-mile diameter, but it should be noted that any object smaller than that would be too faint for detection. There is probably no natural distinction between the smallest asteroids and the largest meteorites.

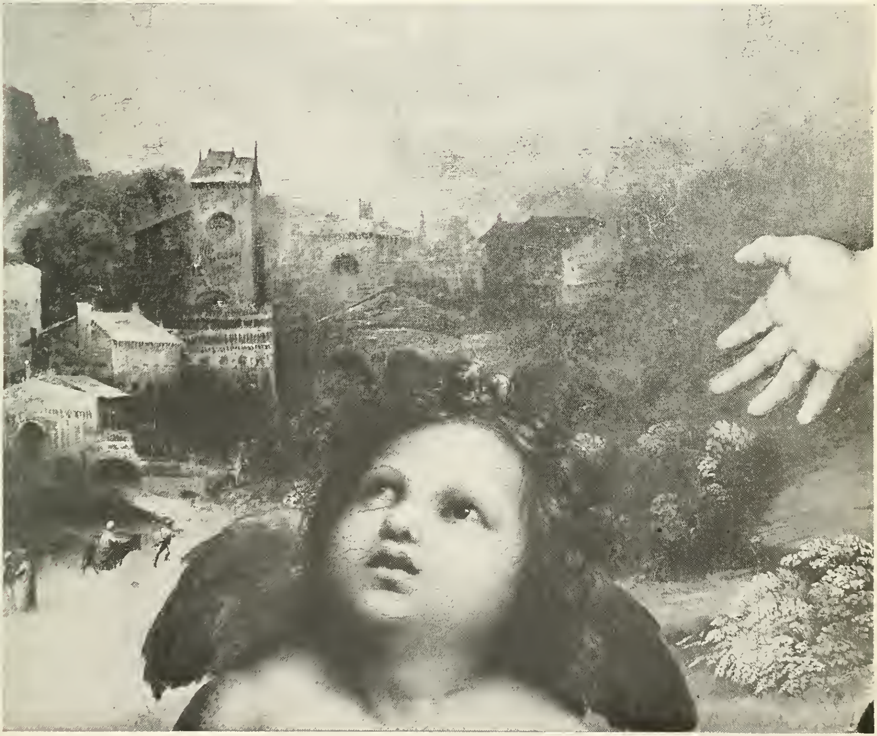
Most asteroids are concentrated in a broad belt between Mars and Jupiter, with orbital periods ranging from three to eight years. There are conspicuous gaps in the belt at distances where the period would be respectively one-half or one-third that of Jupiter. If an asteroid were found at either of these distances, its period would be commensurable with Jupiter's. The latter would cause a strong gravitational perturbation on the asteroid twice (or three times, as the case may be) during each of the giant planet's revolutions. The cumulative effect of these perturbations would gradually shift the asteroid into a different orbit.

On these pages Mrs. Gossner presents the ninth in her 1963 series—a co-ordinated review of the solar system.

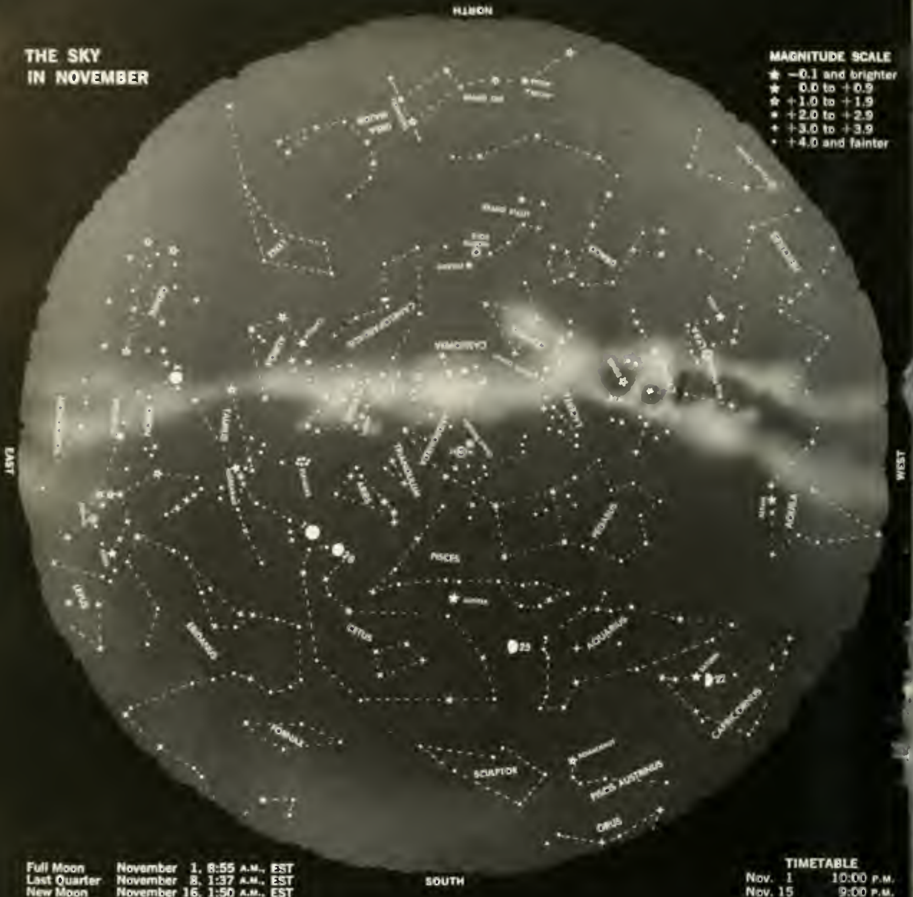
Outside the belt between Mars and Jupiter are found a number of asteroids with highly elongated orbits. One of them has an orbit so eccentric that it penetrates Mercury's orbit once in every revolution. It was named Icarus, for the Greek hero who tried to fly to the sun.

Most asteroids reflect the sun's light irregularly. From brightness measurements it has been found that they must be misshapen bodies. Quite probably they are fragments of larger asteroids that collided in the past. Although the probability of collisions is extremely small at present—only one such collision is expected in a billion years—it will increase gradually as fragments become more numerous, until the entire belt eventually grinds itself into dust.

Painting by Raphael, "Madonna di Foligno," *left*, depicts fall of meteorite on Conti house, right in detail, *below*. Nobody was hurt, and painting was commissioned for Conti family chapel in gratitude for their "miraculous escape."



THE SKY IN NOVEMBER



MAGNITUDE SCALE

- ★ −0.1 and brighter
- ★ 0.0 to +0.9
- ☆ +1.0 to +1.9
- • +2.0 to +2.9
- + +3.0 to +3.9
- · +4.0 and fainter

Full Moon	November 1, 8:55 A.M., EST	
Last Quarter	November 8, 1:37 A.M., EST	
New Moon	November 16, 1:50 A.M., EST	
First Quarter	November 24, 2:56 A.M., EST	
Full Moon	November 30, 6:54 P.M., EST	

TIMETABLE

Nov. 1	10:00 P.M.
Nov. 15	9:00 P.M.
Nov. 30	8:00 P.M.

(Local Standard Time)

Mercury will be in superior conjunction during the night of November 4-5 and will be too near the sun to be observable in the first half of the month. Even by month's end it will be very low in the evening sky, setting only twenty minutes after sunset and still difficult to see.

Venus (−3.3 magnitude) will be very low in the southwest, setting forty-five minutes after the sun November 1, seventy-five minutes after November 15, and one hour and forty-five minutes after on November 30.

Mars (+1.5 magnitude) will also be very low in the early evening sky, setting about an hour after the sun all month.

Jupiter (−2.4 magnitude), in Pisces, will be the planet most suitable for observation this month. Up in the east at dusk, it will remain visible the better part of the night, setting at about 4:30 A.M., local time, on November 1, 3:15 A.M. on November 15, and 2:00 A.M. on November 30.

Saturn (+0.9 magnitude), in Capricornus, will be over the southern horizon after sunset and will set in the southwest around midnight on November 1, 11:00 P.M. on November 15, and 10:00 P.M. on November 30.

Two meteor showers may be expected this month: the Taurids on November 5 and the Leonids on November 16. Under the best viewing conditions, both have a maximum rate of approximately fifteen meteors per hour (as seen by a single observer), but the presence of a gibbous moon on November 5 will probably reduce the visibility of the Taurids.

As the winter constellations return to our evening skies, the visual observer will be treated once again to the familiar display of the group known as the Royal Family. Named for the protagonists of a Greek myth, members of the group include Cepheus, Cassiopeia, Andromeda, Perseus, Pegasus, and Cetus. The first two are circumpolar at our latitudes, but the others are best seen at this time of the year.

In addition to being among the most attractive constellations, the following contain a notable variety of interesting objects: Andromeda harbors the Great Nebula, a near twin of our own galaxy; Perseus has Algol, the prototype of eclipsing variables, and a beautiful double cluster; Cetus has Mira, the "wonderful" irregular variable; Cepheus is best known for Delta Cephei, prototype of Cepheid variables; and Cassiopeia, which is nearly overhead in the early evening, sits squarely on a narrow section of the winter Milky Way.

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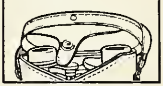

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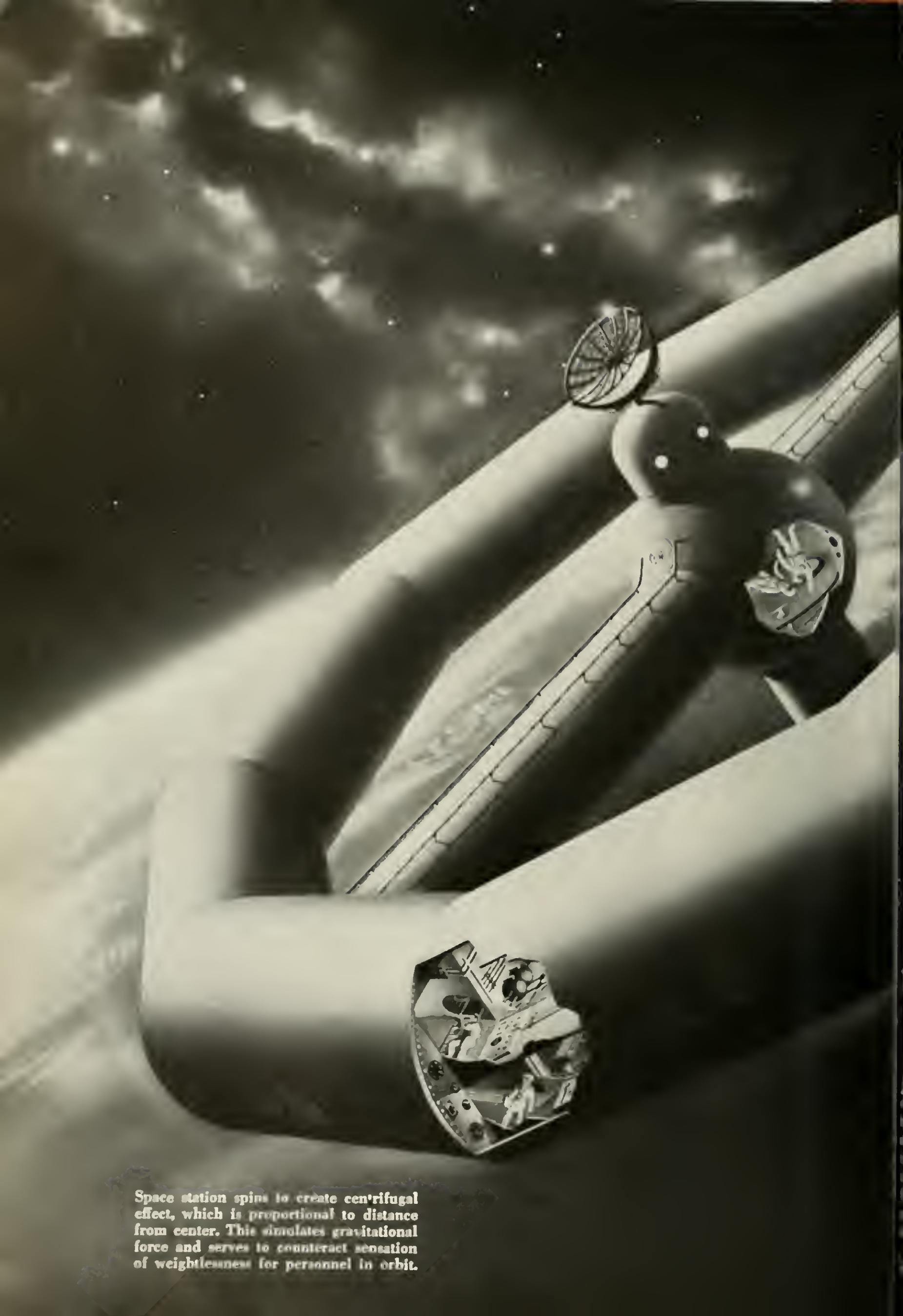


Space station spins to create centrifugal effect, which is proportional to distance from center. This simulates gravitational force and serves to counteract sensation of weightlessness for personnel in orbit.

Part II

Gravitational Forces and Effects

Throughout the solar system, gravitation is the dominant force

By Kenneth L. Franklin   Drawings by Helmut Wimmer

As we discussed last month, there can be serious misunderstandings f everyday experiences. We all have eard the squeal of tires as a car cor-ers too rapidly. The passengers tend o slide toward the outside during the urn, and the usual explanation for hese effects is that "centrifugal force ushes the passengers to the outside f the car." Not true.

Consider a passenger who is sitting n a car that is moving rapidly down the road. When the car begins to turn, the passenger, obeying Newton's first law of motion, has a tendency to continue in a straight line. Friction with the seat cushions transfers the car's change in motion to the seated passenger, who now follows the curvilinear path of the car. If the car's turn is rapid enough, the friction may not be sufficient to transfer the change to the passenger. He then slides to the side of the car "because he experiences a force pushing him out of the car." In reality, the car slides out from under him, until the side of the car pushes him into the turn.

The push of the side of the car on the passenger is a force directed to the center of the curvature of the turn. This is a real force, named the centripetal force. The apparent motion of the passenger with respect to the car is obviously not caused by a force acting on him at all, but is simply due

PASSENGER in a turning car moves in a straight line until door of vehicle forces her to follow curvilinear path.

to a lack of communication, or "coupling," between the car and the passenger. Since ramifications of this aspect of acceleration are generally unfamiliar, it is easy to ascribe the effect to a force operating away from the center of curvature of the turn, the so-called centrifugal "force." This is a completely fictitious force, and the phenomenon should always be labeled a centrifugal *effect*.

THE points of confusion seem to be in the turning, and in the relation between force and inertia. If the car traveling a straight road were brought to a sudden stop without turning, the passenger would tend to be thrown forward. Most people would not say that a force from the rear pushed them to the front of the car when it stopped, but they might say (correctly) that their inertia carried them forward. On the other hand, when the car turned they would probably think of a force thrusting them away from the center of the turn. In both cases, inertia and Newton's first law are responsible for their apparent motion.

Newton's third law is operating also. Suppose a second person were involved. He, too, would slide toward the outside of the car. He would be pushed around the turn by the force of the car door transmitted through the first person. The first person, however, would feel the side of the car pushing from one side and the second person pushing on him from the other side. This second "force" is due to the equal and opposite reaction of the second person to the action of being pushed around the turn by the first passenger. The reaction could not exist if there were no action. This resistance of a mass to the action of a force is the inertia of the mass.

Since the person next to the side of the car has the impression that the second person is "forcing" him into the side of the car, it is easy to understand how people have the idea that the centrifugal effect is a force. This inertial force is actually used in devices like the centrifuge that separates milk and cream. Milk is denser than cream; that is, it has more mass concentrated in a cubic inch than has cream. If left alone, the cream would ultimately rise to the top of the bottle. Actually, the acceleration of gravity pulls the milk to the bottom and squeezes the cream to the top. An acceleration from any cause acting on the masses involved will achieve the same results (Newton's second law), and the acceleration toward the center of a centrifuge may be made much larger than the acceleration solely because of gravitation. The inertia of the denser milk (proportional to the mass) is greater than that of the cream, so milk resists the centripetal acceleration more.

At the earth's Equator, a body is accelerated toward the center of the earth by the force of gravitation owing to the masses of the earth and the body. In addition, the earth is rotating so that the body is allowed a certain free fall toward the center along with its motion sideways. The effect of the lateral motion on the body is the same as the inertial tendency (Newton's first law) to continue moving in a straight line tangent to the earth's Equator. The combination of gravitation and inertial reaction to the rotation results in an apparent decrease in the total acceleration. Since Newton's second law allows a net acceleration to be produced from unspecified sources, the effect is an apparent decrease in the force attracting a body toward the earth's center. The "force of gravitation" is the force attributed to mass only, while the "force of gravity" is the combination of the mass force and the inertial reaction (*Part I* October, 1963). The force, and consequently the acceleration, of gravity changes with latitude, being greatest at the poles and least at the Equator (*diagram, pages 18-19*).

THE inertial reaction can be substituted for the gravitational action in order to produce artificial gravity in an otherwise weightless situation. If the inertial reaction is equal in magnitude to the gravitational action, it is said that "a force of one g is operating." Ten "g's" is a reaction equal to ten times that normally caused by gravitation at the earth's surface. Zero g is weightlessness. This condition encountered in orbit may be an annoyance if endured over a long period of time. For this reason, the large space stations described in popular literature often are supposed to rotate at a speed sufficient to cause an artificial gravity of nearly one g at their outer edge *(pages 44-45)*.

If the inertial reaction could be made equal and opposite to the gravitational acceleration in some artificial way, one could achieve the effects of weightlessness without leaving the earth. One would really be in an orbit for a few moments. This has actually been done on an experimental basis by flying an airplane along such a path that at each point its speed and direction of flight were what they would be in a natural orbit at that altitude.

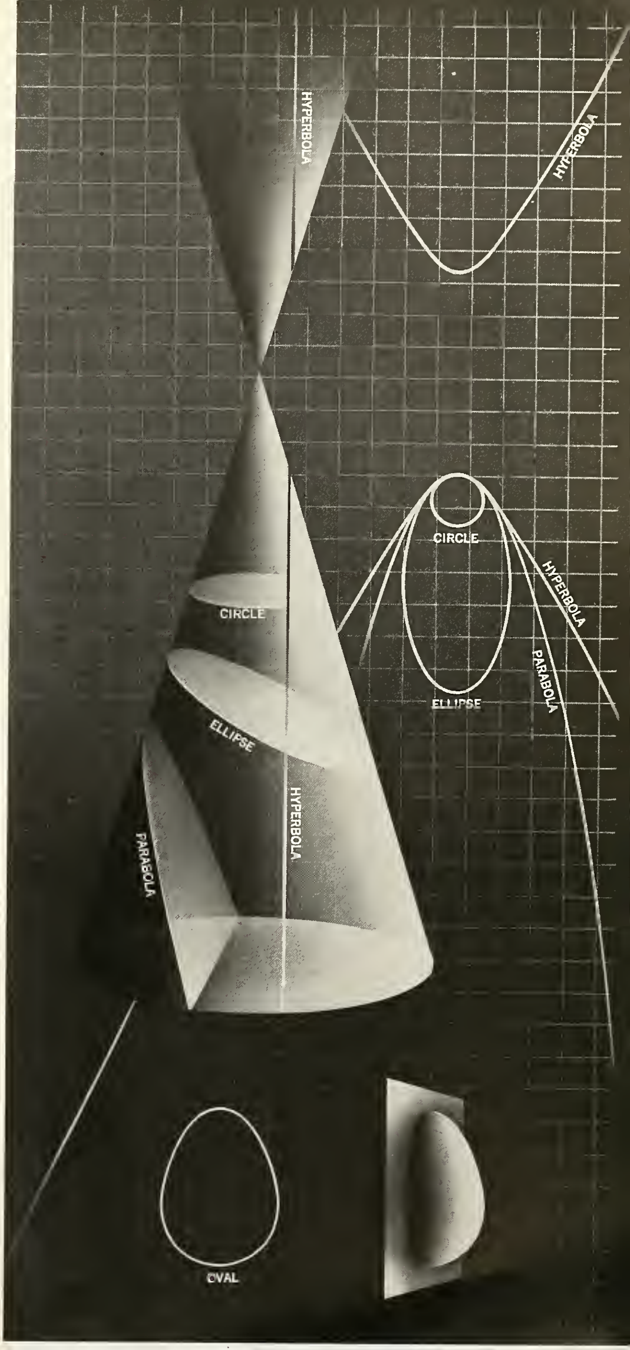
There are times when the inertial reaction, or resistance to change of motion, seems undesirable. When a car is stalled and the driver must push it, he first must "overcome its inertia" to get it rolling. He must continue to push it after it is moving in order to counter the effects of friction, but inertia will allow the pusher to rest while the car coasts a few feet. He does not like inertia at the beginning, but he is quite happy about it later. When the car must be stopped, he can pull back on it, again overcoming its inertia. He would probably say that pushing the car was a lot of work, and physically speaking, he would be correct.

Work is performed when a force is applied to a mechanical system and the system consequently changes its position. The driver applied a force to the car when he pushed it. The amount of work he did is calculated by multiplying the force he used by the distance he and the car moved while he pushed. This is work done on the car. When he pulled the car to a stop, the car worked on him.

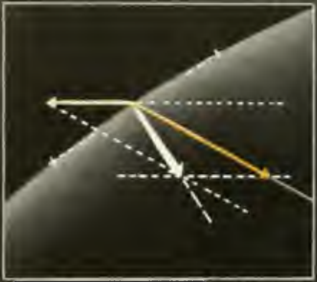
All this is very tiring, and he might say that he had no energy left to push the car again. Again he would be correct, because energy is the capability to do work. The stalled automobile cannot work. The man expends energy "overcoming inertia" to get the car rolling. The car is now capable of performing some work on the man when he wants to stop its motion. If he applied the brakes to stop the car and then felt the brake drums, he would find them very hot. The energy of heat came from the energy stored in the motion of the car. Inertia, then, shows up when there is a change in the energy of motion of a mechanical system of masses; that is, when an applied force results in an acceleration.

In a mechanical system two forms of energy are considered: energy of motion, and energy of position. These are called kinetic, and potential, energy, respectively. The wrecker's ball uses potential energy in breaking up pavement. The winch lifts the ball at a constant rate of speed by applying a force to the cable. When the ball has been raised to a sufficient height above the pavement, it has stored up potential energy. So long as it hangs suspended, it is able to do work, but has not done it yet. When the brake is released and the ball falls, the potential energy is converted into more and more kinetic energy as it accelerates. Just as the ball strikes the pavement all of its potential energy has been converted into kinetic energy and the kinetic energy is used to break the pavement. In the final fraction of a second the pavement brought the ball to a halt. "It isn't the fall that hurts; it is the sudden stop."

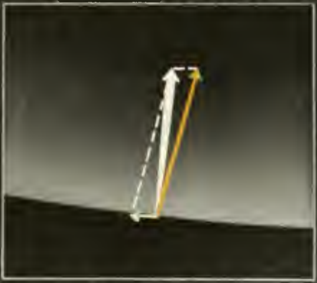
The winch worked to raise the massive ball by applying a force equal to the weight of the ball multiplied by the height to which the ball was lifted. The work done on the ball in this case is equal to the potential energy "pumped" into the system. Except for starting and stopping the ball in its rise, there were no accelerations of the ball by the force that was applied to it.



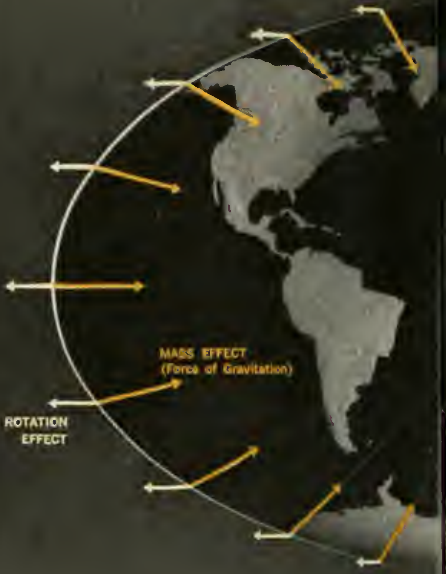
Bodies in orbit follow trajectories hat are conic sections, mathematical curves formed by planes intersecting a cone. Closed curves permit periodic returns; open curves are escape paths. Oval (not a conic section) is no orbit.



Mass and rotation effects at mid-latitudes result in a moderate to low gravity vector.



Rotation at high latitude has little effect, so gravity vector is greater than at Equator.

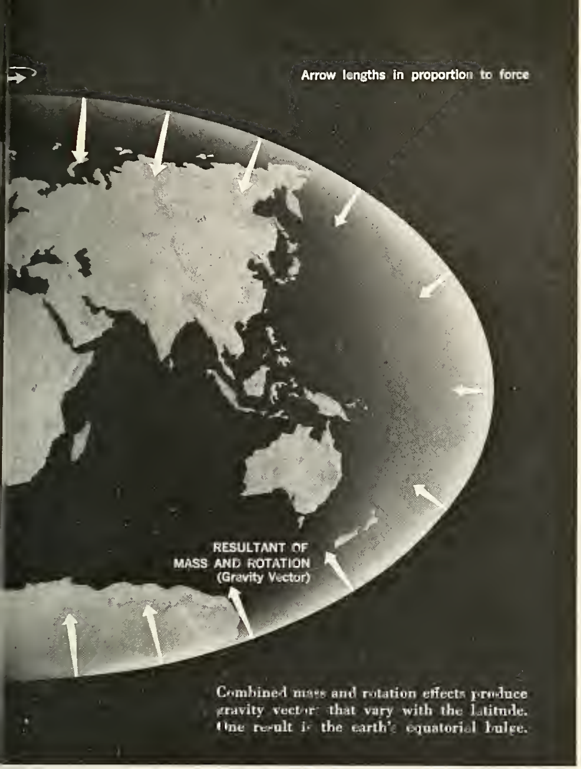


If the whole crane and ball were mounted on a balance, one could weigh the apparatus during various parts of its operation. Only the crane would affect the scale while the ball was resting on the ground. While the ball was being raised, the scale would steadily indicate the weight of the ball added to that of the crane. When the ball is released, the weight of the crane alone would be indicated and no effect of the ball would be observed during the drop, or while in contact with the ground. The force used to raise the ball is consumed in supplying the ball with potential energy, not with supporting it against the earth's pull.

A body in orbit has considerable energy. In the case of artificial satellites, this energy must be injected into the orbiting body by the rocket motors. At lift-off, the vehicle rises from the ground. As its altitude changes, its potential energy increases. Since the altitude increases ever faster, the vehicle is also experiencing an acceleration, hence its kinetic energy is being increased. An astronaut aboard the craft is experiencing "g-forces" (inertial reactions) because of the change of kinetic energy. As the vehicle tilts over and begins to go down range, the thrust of the rocket motors is more dedicated to increasing the kinetic energy while the increase of potential (altitude) energy is slowed. When the total energy is sufficient and is properly distributed between potential and kinetic forms, and the vehicle is headed in the correct direction, the motor is turned off. The vehicle has been injected into an orbit. All inertial reaction ceases and the astronaut experiences zero g—he is weightless.

In general, his orbit will not be a circle but an ellipse. In such an orbit it moves from a point closest to earth, the perigee, to a point farthest from earth, the apogee, in just half the time required for a complete revolution. If the distance from earth changes, the potential energy changes. Recall no that Kepler's second law of orbit motion notes that the orbiting bod must travel fastest at perigee an slowest at apogee. Along with a chang in potential, there is obviously change in motion between the tw points. Throughout the activity of th satellite, the total energy remains co stant while both kinetic and potentia energies fluctuate. What one form o energy loses it yields to the other for so that their total remains a constant

THE amounts of energy apportione between the kinetic and potentia forms strongly influence the shape o the actual orbit. When only two bodie are considered, such as the earth an a satellite, the satellite orbit will be closed curve if the kinetic energy i less than the potential energy. For instance, if, over a complete revolution the kinetic and potential energies eac remain constant, the orbit is a circle If they vary, the path is an ellipse


Arrow lengths in proportion to force
RESULTANT OF MASS AND ROTATION (Gravity Vector)

Combined mass and rotation effects produce gravity vectors that vary with the latitude. One result is the earth's equatorial bulge.

When the kinetic energy exceeds the potential energy, a hyperbolic orbit results. When the two forms of energy are equal at every point in the path, the path is a parabola. Both of these shapes are open-ended, so the satellite would not turn back to approach the earth. These are "escape" orbits, but even so, the satellite is always influenced by the earth's gravitation.

The orbiting satellite is freely reacting to the force of gravitation; it is continually falling, continually accelerating by changing direction and speed, continually altering its amount of kinetic energy, yet never is there an inertial reaction to all this change—never is there a centrifugal effect! Considering all that has been said, this is surely a paradox, or a failure of the laws of motion that work in all other situations. Paradoxes usually indicate the existence of a flaw in the fabric of scientific knowledge and dictate a careful survey of the interlocking threads of reason.

Since no natural thing is allowed to violate a law of nature, something may be wrong with man's understanding of the law, or it is expressed incorrectly. One approach to the present paradoxical situation is to examine the way gravitation affects bodies to see if it acts differently from any other force. In the turning automobile experiment the vehicle actually slid out from under the passenger. The passenger did not participate in the turn until the car door pushed him. Actual contact was necessary. Gravitation acts at a distance with no mechanical contact required. Obviously, then, gravitational force is different from mechanical force.

The astronaut and his capsule are falling freely together. The operation of the retro-rockets is a mechanical force applied to the capsule. The astronaut and any "floating" objects are not accelerated until they make contact with the capsule walls. If it were possible to accelerate the vehicle by a sudden change of gravitational force, the capsule and all its contents, floating or not, would change direction and speed together with no change of relative motions. There would be no inertial reaction, because this reaction depends on the operation of a mechanical force. If the astronaut were to close his eyes when this hypothetical pulse of gravitational force were applied, he would not sense when it worked nor for how long a period of time. "Every pound does its own falling."

There are, however, certain effects of gravitation that masquerade as results of application of mechanical forces. These arise when freedom to react to the gravitational force is restricted. This leads to an alternative point of view that has very far-reaching consequences. Consider a physicist who was born and educated in an underground laboratory, with absolutely no knowledge of the outside world. He could learn all of the mechanical laws described here. He might be led to believe that his weight were in reality an inertial reaction to a constant upward acceleration. This conclusion might result if there were no gravitation in the universe. In this sense, a man in a chair would feel the pressure of the springs holding him up (*see Part I*) and could think that all such pressures, including the centrifugal effect, were the results of accelerations. Indeed, the physicist might conclude that he was really on the inside of a great wheel that was rotating (like the large space station generating artificial gravity), and he could successfully demonstrate the rotation of his underground laboratory. (There are a handful of people in the world who staunchly believe this situation to be correct.)

If now the physicist were exposed to the solar system and the galaxy, his notion about a constant upward acceleration producing an inertial effect would require change. It is clear that a real mechanical acceleration must result in a velocity (a change of position), but the physicist is always the same distance from people at the antipodes who are constantly accelerated in the opposite direction and on the outside of the earth, at that! In pondering the weightless astronaut, the physicist in desperation might decide that a body in orbit is really experiencing no forces at all.

Something like that conclusion may be drawn from a study of relativity and a more general concept of geometry. One may start by defining a line as the shortest distance between two points and parallel lines on a surface as lines that will meet only if extended to infinity. On a surface, a line that is the shortest distance between two points is called a geodesic. The nature of the surface will be dictated by the results of modifications to some basic propositions of high school geometry.

A. Given a point and a geodesic; there is only one geodesic passing through the given point parallel to the given geodesic. This results in a planar surface and Euclidean geometry.

B. Given a point and a geodesic; there are an infinite number of geodesics passing through the given point parallel to the given geodesic. This is a surface of negative curvature, such as a saddle and its properties constitute Riemannian geometry.

C. Given a point and a geodesic; there are no geodesics passing through the given point parallel to the given geodesic. This is a positively curved surface, shaped like a ball, the geometry of which is the result of the work of Lobachevsky.

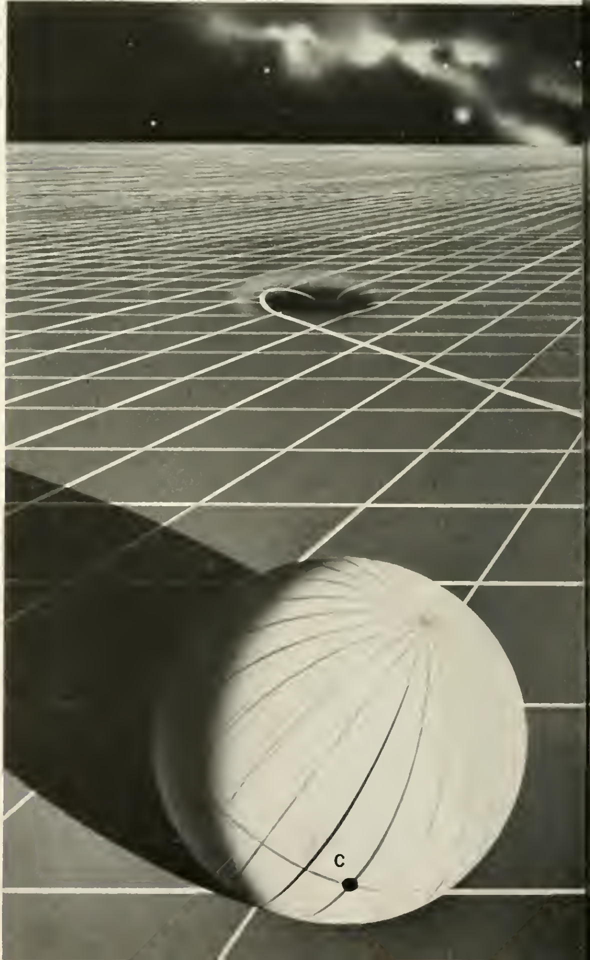
EACH of the three statements has resulted in a formidable geometry of surfaces. Each, and others, may be expanded into a third or a fourth dimension. Algebra already exists for a space of any number of dimensions. In Euclidean geometry one is accustomed to think of the shortest distance between two points as a straight line. On a sphere, such a line is part of a great circle. In higher dimensional space, the laws governing "shortest distance" may result in a geodesic that is not fully recognized as such in everyday thinking.

Now Newton's first law may be generalized to state that a body will continue to move along a geodesic with constant energy unless acted upon by a force. Some of the results of relativity theory indicate that a mass may locally alter the "curvature" of space so that geodesics appear to be the familiar conic sections of Euclidean geometry: circles, ellipses, parabolas, and hyperbolas. The modified form of Newton's law is much more general and in many ways much more satisfying. An astronaut in orbit actually experiences no forces until his retrorockets alter the direction of motion and change the total energy of the satellite in orbit. Then the whole satellite experiences all inertial reactions in the situation. For a few seconds a force other than gravitation acted.

What is this peculiar property of mass in the universe? Obviously, gravitation is the dominant force in the solar system and between the stars. It cannot be altered, directed, shielded, or reversed by any known methods. It is one of the forces, such as magnetism or electrostatic charge, that can act at distances, without bodies actually contacting each other. These field forces are fundamental in nature and have thus received a tremendous amount of attention.

Electricity and magnetism were recognized by Michael Faraday as being mutually interconvertible. About a hundred years ago, J. C. Maxwell expressed this relation in a mathematical form. The solution of Maxwell's equations predicted that electromagnetic waves could be propagated at the velocity of light, which was verified twenty years later by Heinrich Hertz. The results of pondering Maxwell's

GEODESICS in plane surface (A) are the straight lines of Newton's first law of motion. They assume other forms in

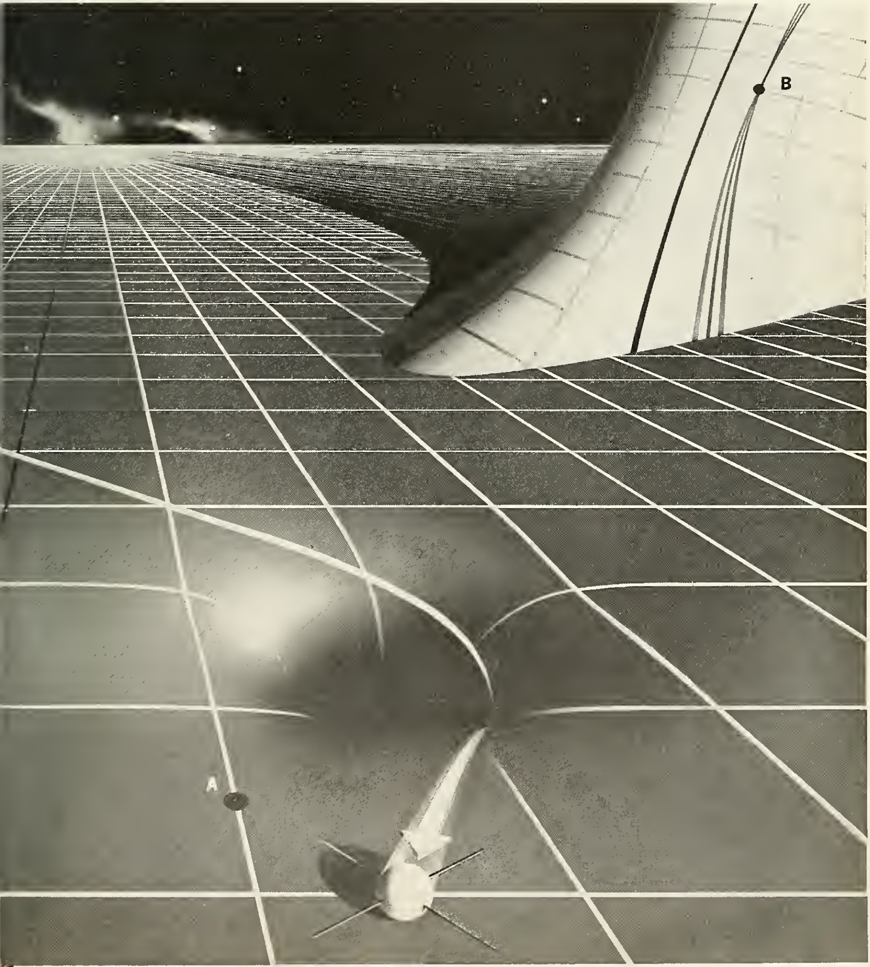


quations of the electromagnetic field re manifest in the radio and television ndustries, in optics and masers and asers. Albert Einstein spent the last ecades of his life attempting to formuate a theory that would unify the lectromagnetic field with the gravitational field. Others have tried, but ll have failed so far. The clue that t is possible is in a disarmingly imple expression that has been uniersally known to newspaper readers ince the end of World War II: $E=mc^2$, energy equals mass multiplied by the square of the velocity of light.

This little equation states that mass and energy are equivalent. The tremendous radiant energy of the sun results from a transformation of mass into energy. It is the principle that is in operation in the energy production of a hydrogen bomb. It also operates when an antiproton is produced or when a proton is annihilated.

Stated a little differently, this expression becomes extremely tantalizing: $E/c^2=m$. On the left of the equal sign may be found all the ramifications of electromagnetic energy, and the applicability of Maxwell's field equations. On the right is mass, with its attendant properties of inertia and attractive force. This statement implies that a conversion is possible, and indeed it has been performed in the laboratory on an atomic scale. However, thus far, the rest of the mathematics has managed to elude the best minds that have attempted the task.

eometry of surfaces that are curved negatively (saddle—B) r positively (sphere—C). In space near massive bodies, geodesics will take the shapes of conic sections. A space probe will follow the curve that requires the least action.



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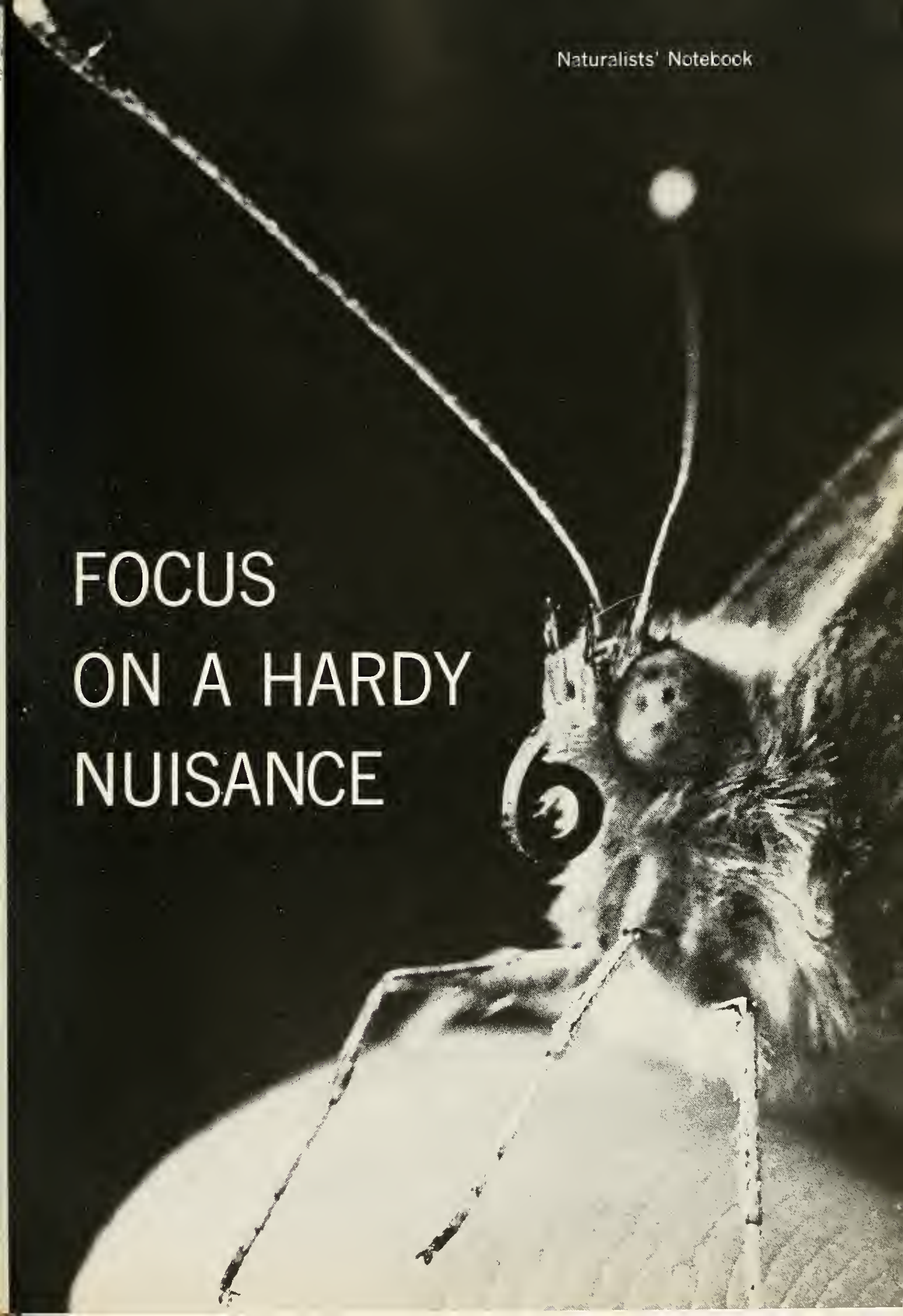


SMALL WHITE BUTTERFLY

A COMMON BUTTERFLY with some unusual characteristics, the small white, *Pieris rapae*, belongs to the Pieridae family. The pierids are worldwide, have more than a thousand members, and include some of the most familiar butterflies.

The small white is found in Europe, where it originated, in most parts of Canada, where it made its first appearance at Quebec in 1860, and throughout the United States, where it was first noticed in New York in 1868. The butterfly's introduction into the New World is assumed to have been accidental, since its larvae are extremely destructive to cultivated cruciferous plants—the cabbages and mustards.

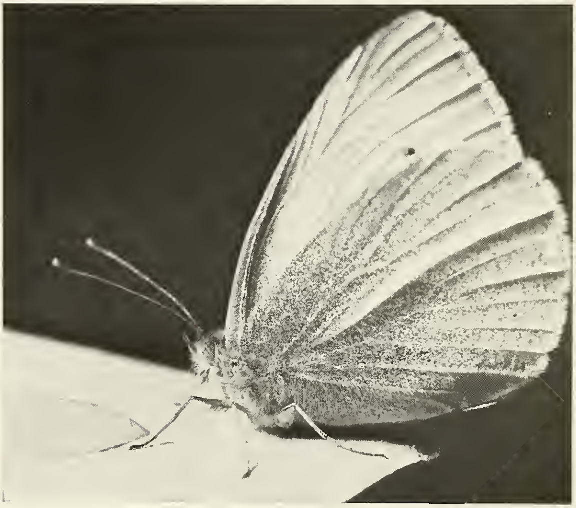
In the northern United States, the small white generally breeds three times a season, and in the south as many as six times. To mate, several males fly in ascending pursuit of a single female, which is ready to lay eggs immediately after mating.

The undersides of cabbage, broccoli, and mustard leaves are customary places for the deposition of eggs. These require approximately a week to hatch into green larvae. The larvae have three stripes along the length of their cylindrical bodies, which have a scant covering of hair.

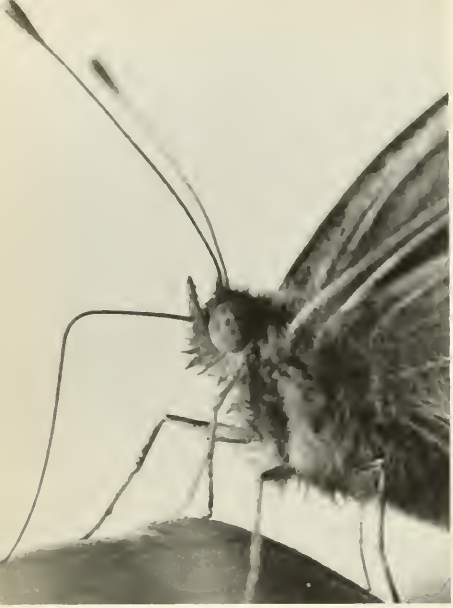
The caterpillar normally feeds for two to three weeks, and it is considered voracious. The larvae of the small white are often known to eat their way right into the heads of cabbage. The larvae molt several times, attaining a full length of one inch with the last molt. They finally stop feeding before entering the pupal stage.

The caterpillar of the small white is often the victim of parasitism by *Apanteles*, a hymenopterous fly. An adult fly stings the young caterpillar, within which several grubs develop and feed. The grubs do not interfere with the normal growth of the caterpillar, but they do deplete the food reserved for the caterpillar's metamorphosis, using it for their own development. A result is that the parasite-ridden caterpillar eats more than an unaffected one and thus is more destructive of crops. (The parasites finally kill the caterpillar not long before the time of pupation.)

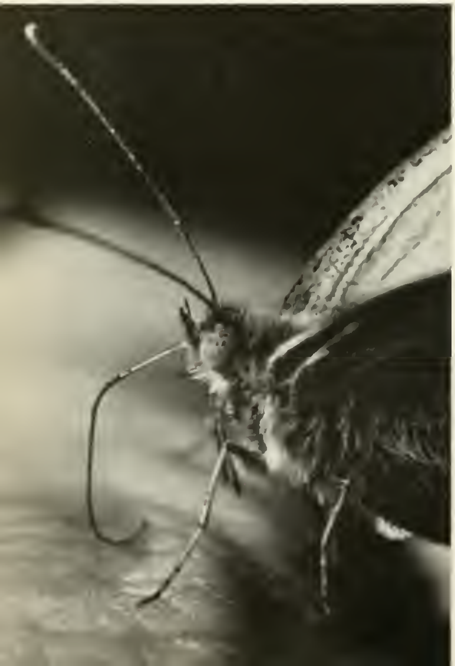
The pupa fastens itself to a twig with a loop of silky-textured thread,



SMALL WHITE butterfly raises its front legs, *left*, when presented with food on tip of match. Single black spot on forewing, *above*, shows insect is male.



Sucking tube of butterfly flicks back and forth (*above* and *below*) in drop of honey, water, and Scotch. Tube ends in a cavity that expands and contracts by muscular action.



and may stay quiescent for ten days or as long as a whole winter if the egg was in the last brood of the season. In the latter eventuality, the small white emerges from its winter casing sometime early in the spring.

As the butterfly's name implies, its over-all coloration is white, except for a black spot on each forewing of the male and two black spots on each forewing of the female, which is otherwise similar in appearance. An unusual characteristic that *P. rapae* shares with other pierids is that its colors are pigments based on uric acid excretory products. This feature, peculiar to the pierids, makes it possible for a researcher to place a butterfly in this family sight unseen, simply by subjecting some of its scales to chemical analysis.

The hardiness and adaptability of the small white, also known as the European cabbage butterfly, are underscored by its success in North America. In the United States there are two native cabbage butterflies—the checkered white (*P. protodice*) and the mustard white (*P. napi*). Neither is as numerous now as in the past, and it seems that *P. rapae* may have driven them from their former grounds, areas where garden plants are cultivated. The two native cabbage butterflies are now found in uncultivated areas.

The small white shown on these pages also testifies to this butterfly's adaptability. Lars Holmberg, a Swedish journalist and naturalist, found it in his home one winter day. Since the outside temperature was about 15° F., Mr. Holmberg assumed that the small white had just emerged from a chrysalis somewhere in his kitchen. Attempts to feed the butterfly with a mixture of honey and water failed until a drop of Scotch was added, on the advice of an entomologist.

Close-up photographs by Dan Segerfeldt show clearly how the small white imbibes fluids with its sucking tube. The tube is coiled in a tight spiral when at rest, but it is straightened and extended for use. Mr. Holmberg noted that the butterfly would sometimes extend the tube even when food was not present and would eat rapidly if food was then made available to it.

After eating, small white curls and uncurls proboscis rapidly, perhaps to clean it, then coils it into a spiral.

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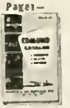

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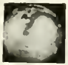

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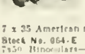

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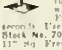

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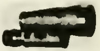

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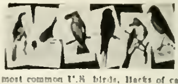

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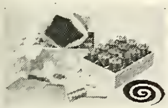

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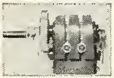

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TRAVEL

FAR AND NEAR

Moroccan Berbers cling to feudal ways

By Colin Wyatt

Whence came the Berbers? Nobody knows exactly. They are probably the oldest inhabitants of North Africa, the descendants of the Libyans of antiquity. Today they inhabit all the mountainous regions of Morocco, especially the Middle and High Atlas Mountains; the Kabyles of Algeria and the Tuaregs of the Saharan mountains are of the same stock. They are a different race from the Arabs, who, after conquering North Africa in the seventh century, drove the Berbers into the hills. The few plains tribes who did not flee were eventually "Arabianized" and assimilated into Arab society.

Historically, the Berbers have had four different religions. One was a naturalistic paganism, to judge by some traces remaining; two of the others were Christianity, acquired from the Romans, and Judaism. Today the Berbers are Moslems. The Atlas Berbers speak their own very distinctive language, which belongs to the Hamitic group, but they have innumerable dialects and have never possessed a written language. Thus a knowledge of Arabic became an essential for the cultivated Berber.

Today some 40 per cent of Moroccans speak Berber and still live a life that approximates that of their forebears. Their communities are distinguished by the absence of civil law. Observance of Islamic law, the *Chraa*, is the basis of their moral and civil life. Even though the Almohade dynasty of the Berbers at one time held sway over an empire embracing all North Africa and Moslem Spain there has never been a sovereign Berber nation. Today these mountain people think of themselves only as Moroccans, for they recognize that they are a geographical and ethnic unit rather than a political one.

In physique, Berbers vary considerably. Some are blond with blue eyes while others are brunet; some are square-headed, straight-nosed, and stockily built; yet others are flat-faced, with almond-shaped eyes almost like those of the ancient Egyptians. These tribesmen have always been a pastoral people often wandering with their flocks, and this has helped to keep them disunited from the Arab culture and way of life. The Berbers have preserved a basically feudal society, somewhat similar to that which still prevails in much of Black Africa, where loose lines of fealty connect many widely different tribes. Even today they retain their tribal group names, as proudly as do the Black Africans and the old Scottish clans.

Moroccan Camelot

Although much of Berber social life is still almost wholly feudal in its static set of tribal relationships, in some ways the Berbers seem quite modern. Women are full equals of men and play a powerful role in society; they have never worn the veil. The Berber seems to be more gregarious, more industrious, and less fanatical than the Arab.

The family is the primary social unit,

and after it the village; if the latter is large, it will be under the control of a sheik, who presides over a village council, or *djemaa*, elected from the heads of the principal families. But often, in an area where the land is poor, there will be several scattered villages that belong to a kaid, whose baronial keep is perched high on some prominent rock, perhaps commanding a valley. From this vantage point he surveys his domains, exacting tribute from his people and probably longing for the good old days when he could raid his neighbor, whose great red redoubt may stand out against the skyline ten miles away.

Within recent memory there were perpetual, petty wars between the rival clans and kaids; they were finally pacified by the French barely thirty years ago. However, the kaid is usually a very benevolent overlord, ruling his people kindly and administering justice with the benefit of close knowledge of the lives of those concerned. He is also responsible for organizing the agriculture and grazing in his valley, and for making amicable agreements with neighboring kaids for the use and distribution of common water supplies for irrigation, the common use of mountain summer grazing land, and so on. Before the French protectorate came into being in 1912, the Berbers paid no taxes to the sultan and governed themselves. In 1934, they came under the rule of the sultan's government. Yet even now the Moroccan government leaves local tribal matters very much in the hands of the kaids, who still cling to their independence and oppose most outside authority.

Although the days of armed quarrels are past, the kaids and villages maintain their walls and fortifications, as much out of ancestral pride as anything else, and the importance of any feudal lord

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may be judged by the size and decoration of his Kasbah. The village ramparts are in any case needed to protect the herds at night from prowling jackals or the occasional hyena, and in the great cedar forests of the Middle Atlas the panther is still a present danger.

Law and Water

ALTHOUGH there is a concentrated agriculture wherever a water supply can be utilized for irrigation, the Berbers remain mainly a pastoral people. Their flocks are their chief source of wealth, and what little trade they carry on is mostly in wool and hides. Everything necessary to life can be found within the village and its surrounding area, and with a true spirit of community the rich assist the poor or stricken, so that no one is ever truly in want. Their hard-won terraces of painstakingly manured soil on the stony mountainsides yield enough barley for bread, as well as a second crop of corn or broad beans. Their flocks provide milk, food, and clothing. Those families fortunate enough to possess a handmill, a water mill, or a loom make them available to their less richly endowed neighbors against a small percentage of the raw material. As in many other parts of the world, the flocks are always enclosed at night, both in the villages and in the walled *azibs* of the high mountain summer pastures, so that the valuable manure can easily be collected, bagged, and transported down to the fields. Water is the essential commodity; a highly organized system of dams and irrigation channels has been developed, subject to a rigorous code of laws for their use. The whole community works at maintaining them, each man furnishing his labor in proportion to the amount of land he owns.

Through Sesame's Doors

IN many ways, theirs is a fairy tale country. Part of it consists of rich forests of vast cedars and oaks or, in a few areas, of pines. Part is brilliant desert with green oases and great rivers that flow down from the snows of the Atlas, bordered with green ribbons of date palms and checkerboards of alfalfa that are hedged with roses and figs. These rivers run on to lose themselves in the sands of the Sahara.

South of the High Atlas one travels through a seductive land where the pink ramparts of castles and fortified villages rise above sinuous belts of cultivation beside the rivers. Every few miles the tapering red towers of a baronial keep, which crowns some rocky spur, pierce the blue sky. All these fantastic strongholds are pink or red, built in the biblical manner of huge mud-and-straw blocks of pisé or sun-baked bricks. They are timeless, for whenever a part crumbles it is promptly rebuilt. Only rarely does one see ruins, reminders of the warring days scarcely thirty years past. Berbers take a great pride in decoration, and incise geometrical designs deeply into the walls during construction. Often a sheik or kaid will have earth specially imported from some distant locality to face the top section of his towers with a brighter color.

The whole countryside is red and purple and yellow, with silver streaks of dry watercourses, and deep purple shadows. The days are hot but the nights are cool, for in the evening the breezes come down from the High Atlas, whose snowy peaks gleam tantalizingly along the horizon. The air is fresh and dry.

In the morning the palms rustle gently around the village and the air is scented with the perfume of roses. Sharp cries and the occasional rattle of stones herald the approach of a flock of goats being driven from the town walls to their rocky pastures, and from somewhere comes the querulous, bubbling bellow of a camel. This is the hour to move, on foot or jogging comfortably along, seated sideways on a donkey. By the time the day gets hot one will have reached the next village to relax in the shade of a spreading fig tree, perhaps resting against the cool bank of an irrigation channel.

Scheherazade Remembered

ONE's approach is certain to have been observed, and sooner or later an emissary of the sheik will appear to bid the visitor to drink mint tea with him, sitting cross-legged on palm mats in a shady corner beneath the flat, earthen roof. While a henchman blows the charcoal brazier, the sheik carefully shreds a bunch of fresh mint, chips some big lumps from a sugar loaf, and carefully puts it all with some green tea into the pewter teapot. After a moment a cup is poured, and is then poured back and forth between cup and pot a few times until the brew is ready; then the three ceremonial cupfuls are drunk with much appreciative sucking and smacking of lips and murmurs of *Bismillah*.

If it is too late in the afternoon to travel on, a spotlessly clean room with rugs spread on the smooth earthen floor, is put at one's disposal. Later the visitor descends to the living room where the hostess produces a wonderfully steamed chicken and a great dish of "couscous," a sort of semolina-rice, with flat cakes of delicious barley bread and a big crock of fresh butter. And after, if a guest is lucky, a few neighbors will come in, maybe with a lute and a drum, to entertain the company with strange oriental songs. It is no exaggeration to say that the present has slipped away—one is transported back into *The Thousand and One Nights* and time is no longer relevant.

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About the Authors

Mr. Karl Kenyon, of the Wildlife Research Branch of the Fish and Wildlife Service, U.S. Department of the Interior, describes the precarious life of the sea otter in "Recovery of a Fur Bearer." Mr. Kenyon is both a mammalogist and an ornithologist; he has studied distribution, population change, and migrations in birds and mammals of the North Pacific and the Bering Sea. An experienced photographer, the author took the picture that appears on our cover as well as those that accompany his article.

Decisive steps in the "detective work" leading up to his decipherment of Minoan Linear A are set forth in the article by Dr. Cyrus H. Gordon, Professor of Near Eastern Studies and Chairman of the Department of Mediterranean Studies at Brandeis University. Dr. Gordon has spent six years in the Near East, four as a working archeologist and two in the Army as an adviser to the commanding general of the Persian Gulf Command. Many of the far-reaching implications of his decipherment of Linear A have been spelled out in detail by the author in his book *Before the Bible: The Common Background of Greek and Hebrew Civilizations*, published in 1963 by Harper and Row.

In "Archipelagic Refuge," Dr. Benjamin C. Stone, Associate Professor and Chairman of the Department of Botany at the College of Guam, discusses the unique nature of much of the flora of the Hawaiian Islands. Dr. Stone received his doctorate at the University of Hawaii, taught there, and was consultant to the Bishop Museum in Honolulu before going to Guam. His current post has allowed him to concentrate further on the taxonomy and plant geography of islands in the Pacific Ocean.

Dr. Kenneth L. Franklin, Associate Astronomer at The American Museum-Hayden Planetarium, concludes a two-part discussion of gravitational forces and effects in this issue. The author has served as a scientific consultant to various institutions, including Republic Aviation Corporation, the Bendix Corporation, and *The New York Times*. He is a member of many scientific societies, among them the Radio Astronomy Committee of the International Scientific Radio Union.

Feudal ways and a castled land belonging to the Berbers of the High Atlas Mountains are depicted in "Far and Near" by British journalist Colin Wyatt. The author operates from a home base in Farnham, Surrey, and his lyrical travel sketches are frequently published in the British magazine *Country Life*.

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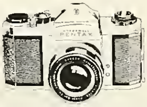

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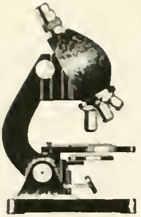


NATURE and the MICROSCOPE

Methods of metallography

By Julian D. Corrington

A phase of microscopy that strongly interests many devotees of the craft is the study of metals, which we preface with a brief discussion of mirrors.

The world's first and still finest mirror is a perfectly calm and clear pool of water, such as the one in which the mythological Psyche surveyed her reflection while kneeling on a rock. Next in historical sequence comes the burnished metallic shield, celebrated of old in the myth of Perseus, who slew the Gorgon Medusa while observing her reflection in his shield because a direct look at her would turn him to stone.

The third form of mirror is the one we employ today, a sheet of glass backed with a metallic deposit, usually silver. This, too, is actually a mirror of metal. The mirror of polished metal is sometimes termed a speculum to distinguish it from the one of glass.

When Alice went *Through the Looking-Glass* she found everyday things reversed in space and time. The law of the mirror is a simple one: the angle of incidence equals the angle of reflection. This means that the angle made by the entering (incident) ray of light to a normal (perpendicular) drawn to the surface of a plane mirror, will be equal to the angle made to this normal by the reflected ray. So a ray incident from the left side of the normal will reflect to the right side to the same degree. If we make a right-hand salute in front of a mirror, our image will make a left-hand salute.

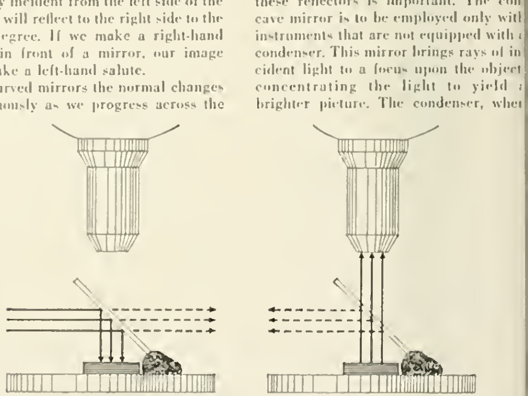
In curved mirrors the normal changes continuously as we progress across the curved surface. A convex mirror makes the reflected rays diverge, spreading them out so that the reflected image covers a much greater area than that of the mirror. Thus we can see our whole head plus much of the surroundings when we look into a small, convex mirror.

Concave mirrors make the reflected rays converge and provide an enlarged image. If a concave mirror is a section of a sphere, the reflected rays may be al directed toward a common center, the focus, and thus it is possible to construc a reflecting microscope as well as a reflecting telescope. The former has never met with success; the latter is the favorite telescope today. The 200-inch reflector of Mount Palomar is an example.

If the curved surface of a concave mirror is a sector of a parabola rather than sphere, it is possible to place a strong illuminant in the center and have all o its rays reflected in a parallel beam, as in a searchlight. This is reflection with focus at infinity, and it has many commercial applications.

Mirrors and Microscopy

Since microscopes are equipped with mirrors that have one surface plane and the other concave, the proper use o these reflectors is important. The concave mirror is to be employed only with instruments that are not equipped with condenser. This mirror brings rays of incident light to a focus upon the object concentrating the light to yield brighter picture. The condenser, when



Cover glass fixed at 45° angle above a metal specimen bounces part of horizontal light beam down for vertical illumination but much loss of light occurs in process present, is an accessory microscope that also brings parallel incident light rays to a focus on the specimen by refraction. Use of a concave mirror with a condenser would defeat this design. Always use only the plane mirror when a condenser is a part of the optical system.

We have all observed our reflection when looking at and through the plate glass of a store front. Some of the incident light rays are reflected back from the front surface of this thick, polished glass, while others pass through and allow us to see the contents of the showcase. In this instance, the glass acts partly as a first-surface mirror, and we use this principle when we turn to the microscopic study of metals. The same effect may be obtained with a half-silvered mirror, in which the applied film of metal is so thin that some of the incident light rays pass through while others are reflected back toward the source.

Metals are opaque to light and may not be observed microscopically by the customary method of transmitted light, which comes from below the object and passes through it. Instead, incident light must be reflected from the object through the optical system of the microscope. In order to prevent light rays of this sort from striking the object obliquely, there are available a number of devices that direct the light downward at a normal to the specimen, which means that the light must come through the microscope itself, since the objective is directly over the specimen. One device for achieving this vertical illumination consists of a horizontal, tubular housing that is inserted between the microscope body and the objective. The housing contains a strong light source, with the beam directed into the microscope tube and downward by a reflector in the housing. The reflector is inclined at a 45° angle. The principle is most easily explained by describing a homemade device often used by beginners in the microscopy of metal structure—metallography.

Lighting Metal Specimens

A cover glass tilted at a 45° angle is held by a lump of Plasticine alongside a polished and etched metal specimen *(shown in illustration at left)*. A strong beam of light is directed upon the underside of the glass from one side, and some of the rays pass through and are lost while others are reflected downward onto the specimen. The polished metal specimen then reflects upward the rays that reach it. Some will be reflected back into the light source by the cover glass, but others will pass through, up the microscope tube, to the eye. The efficiency is low and only about 25 per cent of the original light reaches the eye, so the source must be powerful.

Another method is to arrange a collar

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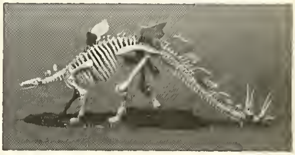

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of tiny light bulbs, housed in a circular reflector, around the sleeve of the objective. The Silverman illuminator, a professional device of this type, uses a circular fluorescent tube. This is not strictly vertical illumination, but the results are excellent. Least efficient, but still useful in this work, is the ordinary gooseneck student lamp, with the bulb in its reflector as close as possible to the microscope, at the level of the nosepiece.

In collecting specimens of metal for microscopic study we need only small bits. Try to secure samples of copper, tin, brass, zinc, bronze, nickel, and iron, as well as steels containing nickel, chrome, tungsten, vanadium, and carbon. A widely used sample size among professional metallographers is ½ inch square by ⅜ inch thick. Such pieces are roughed out with a hacksaw or snips and placed in a vise for preliminary smoothing with files.

Preparing Metal for Study

To polish the specimens, first use files of decreasing coarseness, then abrasive papers such as emery, sand, and carborundum, and finally polishing agents such as powdered rouge or levigated alumina, always using finer materials as the work progresses. The motions used in these polishing steps must always be in one axis only, never rotary or irregular. Each successive operation must be performed at right angles to the preceding one, until the scratches made by the first are completely removed by the second. Thus, if the first filing is done in a direction that we may, for convenience, call north-south, then the second should be performed east-west, the third north-south again, and so on. Bevel the edges of the piece to a 45° angle.

After each stage of polishing, flush and dry the metal. Abrasive papers are best handled by fastening them to a perfectly flat hardwood block; the rouges or alumina are most easily applied with a small piece of clean, damp chamois stretched tightly over a hardwood block and secured by thumbtacks. After each polishing operation wash the metal and the chamois thoroughly so that no particles of a coarse material will contaminate a finer agent. At the end of the polishing series the specimen should be absolutely smooth and bright, like a fine mirror. Handle the metal with forceps, grasping it only by the sides. Do not touch the shining surface with the fingers or any implement.

Reagents Etch Sample

Now the specimen is ready for etching with weak acids or alkalies. The reagents attack some of the metallic crystals more than others, thus bringing their boundaries into relief. Light rays falling

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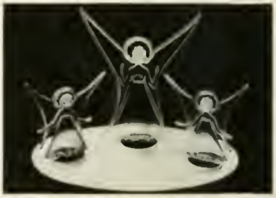

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upon the object from above will then not all be reflected in parallel, as from an unetched metal surface, but will be scattered and hence reveal outlines of components that would otherwise be concealed. The etching is somewhat like developing a photographic negative.

The metal block, held in forceps, is dipped into the etching fluid for fifteen to twenty seconds, then is washed immediately in water. The specimen should be swirled about to remove all traces of the etching agent, then examined microscopically to see if it is sufficiently etched. If not, repeat the process until the result is satisfactory.

For iron and steel, use 10 per cent solutions in water of hydrochloric, nitric, chromic, or picric acids, as well as nital or ammonium persulphate. For copper and its alloys use 50 per cent ammonia in water or 10 per cent caustic potash. Heat treatment during the manufacturing process will often make etching unnecessary. The cast irons are examined unetched.

To prepare a specimen for examination, place the metal piece face down on a perfectly clean slide, then surround the inverted sample with a metal or glass ring that is a trifle higher than the object. Alternatively, use two wooden blocks of identical height cut from the same piece of polished hardwood, and put one block on each side of the sample. Place a small lump of Plasticine in the center of a second slide and invert this over the metal block, pressing down firmly. The Plasticine now holds the metal block to the slide with the polished metal surface parallel to the glass. Lift the slide up, carrying the metal block with it. Store the prepared slide in a glass jar in which a small container of calcium oxide has been placed to prevent rust. Filings, wire, and other small metal objects may be ground, polished, and etched by arranging them in a small mold, using a magnet to orient them if necessary. Then fill the mold with molten Wood's metal. When cold, the entire block is processed as previously described. Electric grinding and polishing machines are available for those who wish to pursue metallography extensively enough to warrant the expense.

Uses of Metallography

The purpose of studying metals microscopically is to determine the minerals present and the size and distribution of their crystals. This procedure is so important that all large companies in the metal industries employ microscopists who have had training or experience in this specialized field. One of the ends sought is control in the manufacturing process, an outstanding example being the heat treatment applied to various steels, on which depend many of the desired qualities. The problem of adulteration is another fertile area for metallographers; even very small amounts of foreign elements radically alter the behavior of a given metal when subjected to stress. And then there is the microscopic study of fractures in metals, with the aim of preventing similar failures.

Microscopic examination shows crack in cutting tool made of Carboloy, steel alloy that contains tungsten, carbon, and cobalt.

The best example of the importance of metallography is steel, which is an alloy and not a metallic element. The basic ingredient of steel is iron, which in pure form is a silvery-white and relatively soft element. Iron has the desirable properties of malleability (can be shaped by hammering or rolling) and ductility (can be drawn out into a wire). But iron also has the undesirable characteristics of being very easily oxidized (rusted) and attacked by numerous corrosive agents. Besides iron, simple steel contains small percentages of carbon, by intent, and impurities such as silicon, sulphur, manganese, and phosphorus. Alloy steels are made by adding to simple steel varying amounts of such metallic minerals as nickel, chromium, vanadium, manganese, molybdenum, and others. Seemingly insignificant quantities of these alloying substances impart remarkable differences to the finished product. Most steels have less than 1 per cent carbon, and none has more than 2.2 per cent. Carbon confers hardness and tempering qualities. Addition of 3.25 per cent nickel to 0.5 per cent carbon steel makes the resulting metal very fine-grained, elastic, and ductile; adding chromium produces an exceedingly hard steel. Chrome-nickel steel is at once hard, tough, and elastic. Manganese steel is hard and either brittle (5 per cent manganese, cooled slowly) or tough (12 per cent manganese, cooled rapidly), while tungsten steel retains its properties even at a dull red heat, and is much in demand for high-speed tools.

Such manufacturing processes as casting and rolling affect the properties of steel, and the heat treatment is especially

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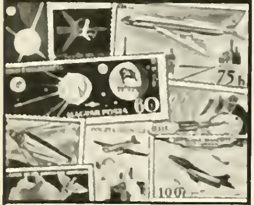

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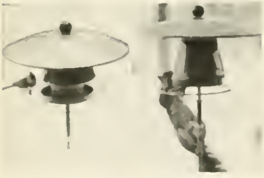

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important. The temperature to which the mass is raised, how long the temperature is maintained, and the method of cooling—whether slowly, as in a molten lead bath or in a furnace, or more rapidly, as in a current of air, or very quickly by quenching in water, brine, or oil—all have much to do with the final properties. The object of such treatments is to control the grain size of the metal and the character and dispersion of the carbon, which influence the hardness and toughness of the finished steel.

Determination of Structure

Pure iron grains, seen when examining a polished and etched section of steel under the microscope, are called ferrite, and are white and homogeneous. In a cast iron that lacks heat treatment and that has a very high carbon content (3.5 to 4.25 per cent), the carbon separates out completely as large flakes of graphite, which appear as black bars and streaks. Such flakes greatly lower the strength of the iron, making easy planes of cleavage in this brittle metal. When heat treatment is used with cast iron, some of the carbon may form graphite flakes, but the remainder will precipitate as carbide, in the form of cementite crystals. These occur in plates or laminae (layers), alternating with clear areas of ferrite, a pearlitic type of structure.

Brass, an alloy of copper and zinc, has much larger crystals than steel, and the grain size is important. Often the crystals are too large, which indicates unsuccessful annealing caused by too high a temperature. Throughout the manufacturing process, reports are made by the firm's metallographer, the technician who takes photomicrographs of polished and etched plates at various stages of treatment. Most examinations are now made with the metallograph, a photomicrographic camera that can reproduce photographically what can be seen microscopically. These pictures are made into projection slides, which can be enlarged to a huge size before an audience of company experts who can then discuss what may or may not need to be done to improve the alloying, the purity, or the grain size of the product. The inescapable conclusion is that metallography is not only an extremely interesting science, but that it is also an indispensable adjunct to industry.

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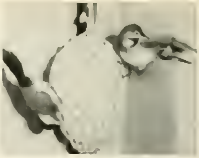

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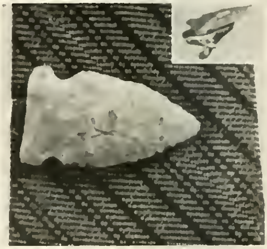

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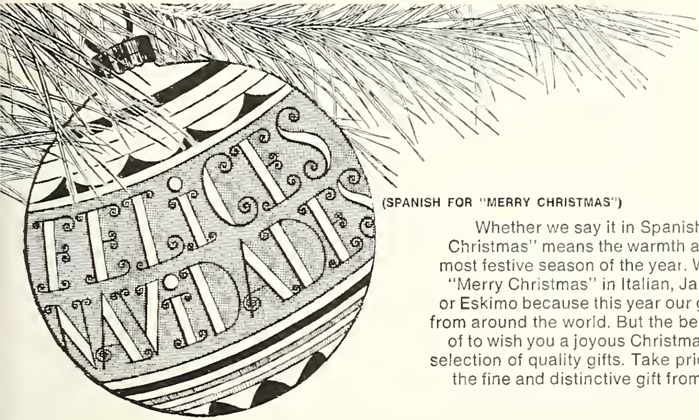

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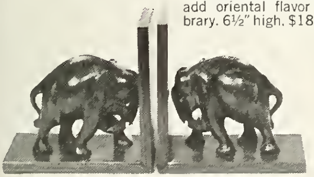

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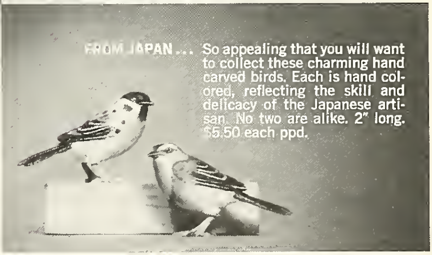

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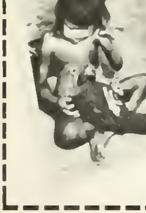

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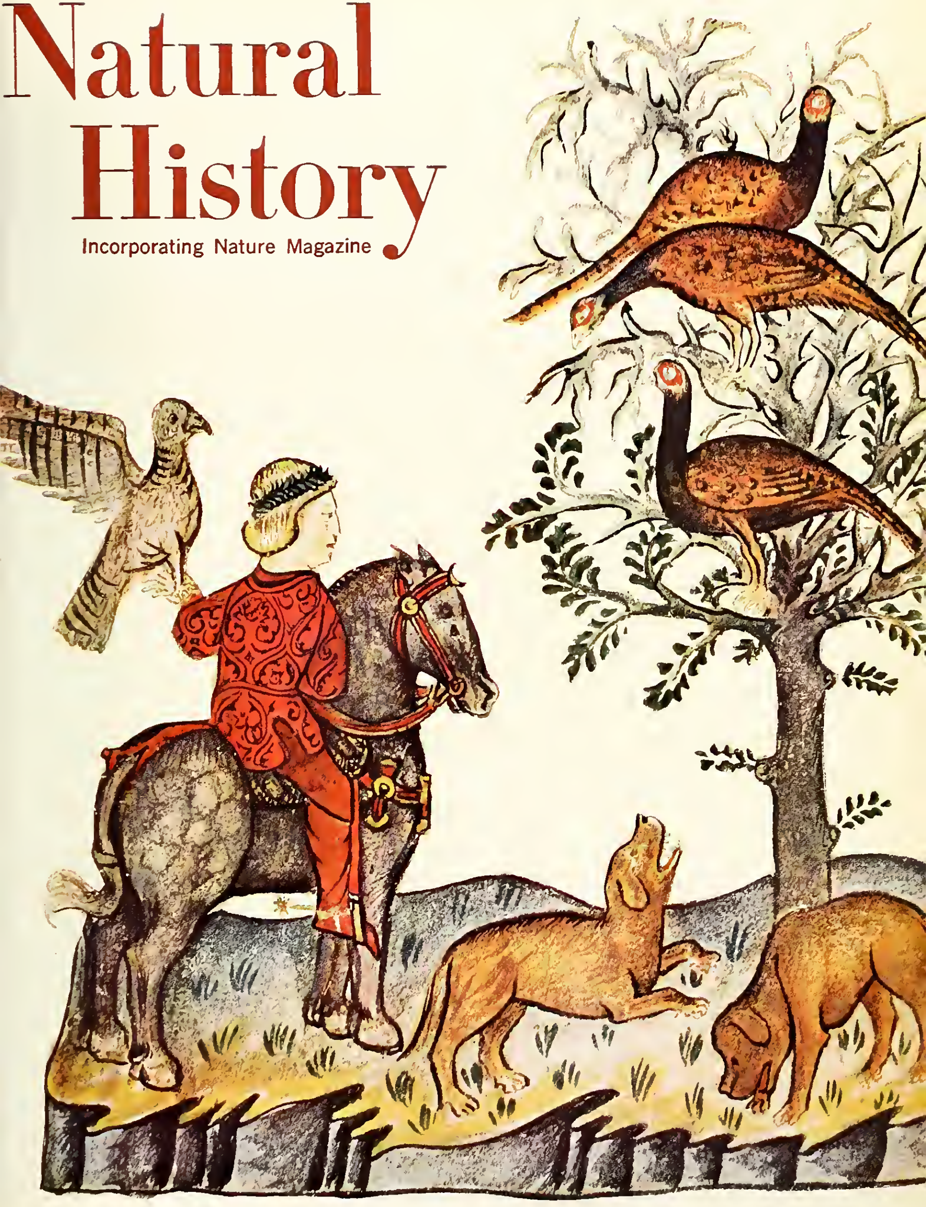

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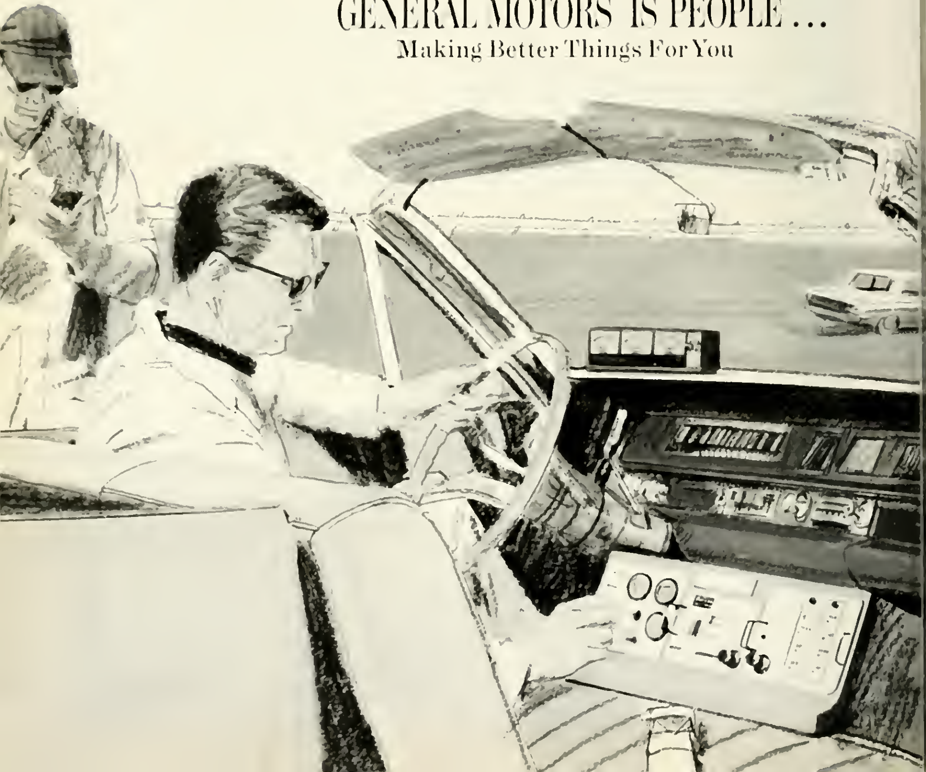

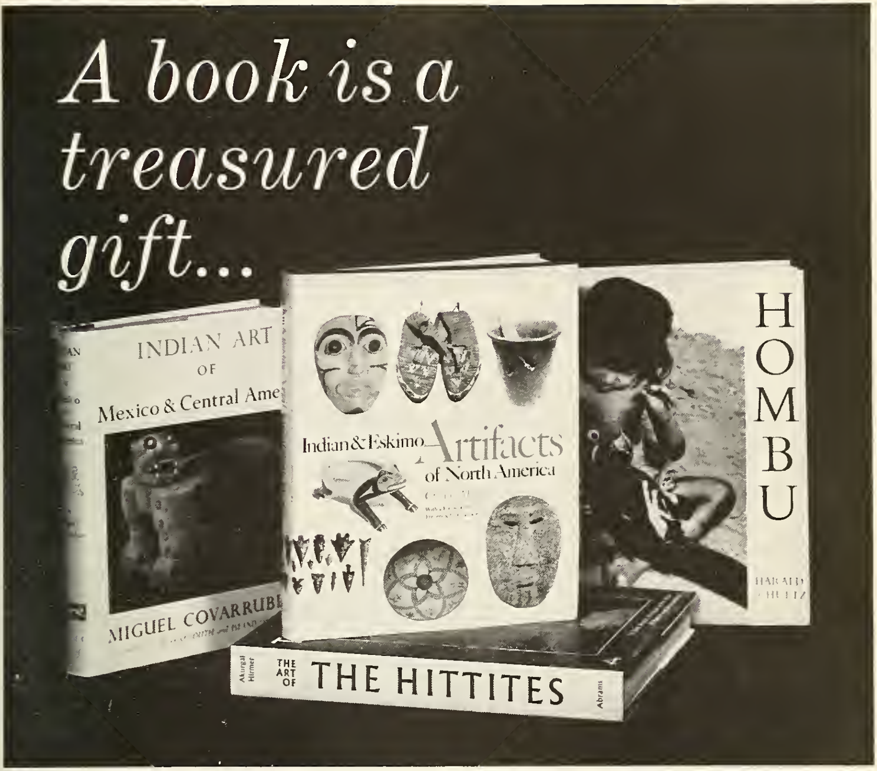
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THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

Vol. LXXII DECEMBER 1963 No. 10

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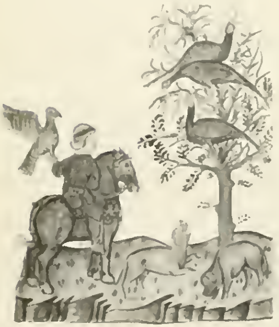

COVER: The falconer pursuing treed pheasants is one of a wealth of vignettes in a 15th-century herbal, recently acquired by the Spencer Collection of The New York Public Library, that describes and portrays plants and simples, food and diet, and social mores of Italy in the Middle Ages. Its importance lies in the way illustrations are used, the variety of genre scenes, and the nature of the text. Unlike most manuscripts of the period, which were made for the very wealthy, this one relates to the average man, and is written in a northern dialect. A discussion of this most unusual work begins on page 30.

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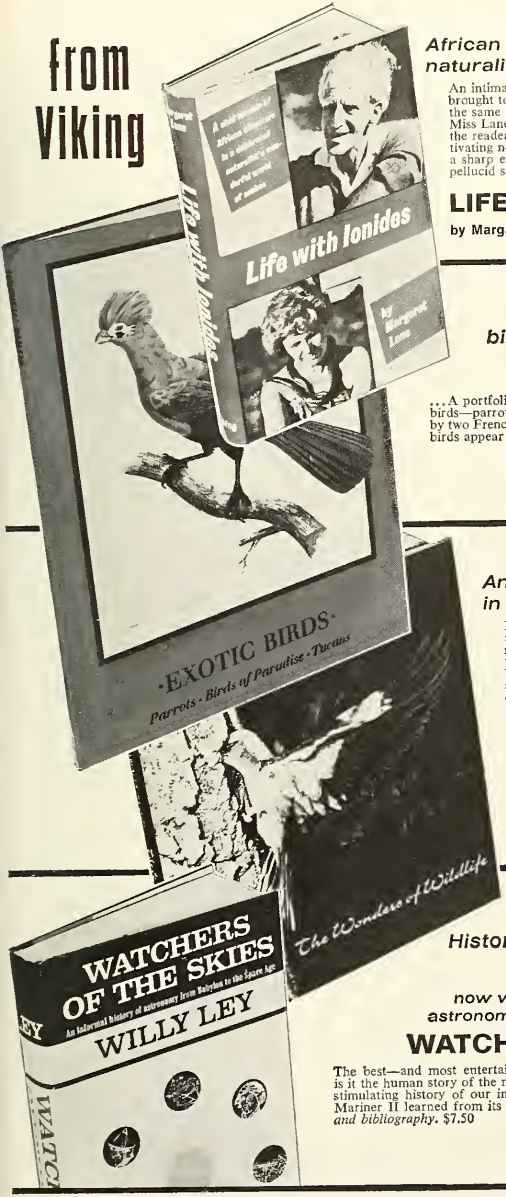
Publication Office: The American Museum of Natural History, Central Park West at 79th Street, New York 24, N. Y. Published monthly October through May, bimonthly June to September. Subscription Price: $5.00 a year. In Canada, and all other countries: $5.50 a year. Single copies: $.50. Second class postage paid at New York, N. Y., and at additional offices. Copyright, 1963, by The American Museum of Natural History. No part of this periodical may be reproduced without the written consent of NATURAL HISTORY. The Title NATURE MAGAZINE, registered U.S. Patent Office. Unsolicited manuscripts and illustrations submitted to the editorial office will be handled with all possible care, but we cannot assume responsibility for their safety. The opinions expressed by authors are their own and do not necessarily reflect The American Museum's policy.



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Reviews

A survey of young people's science books published in 1963

THE PAST YEAR has seen a number of encouraging developments in long-term efforts to improve children's science books. Although sloppily edited books with confusing and inappropriate illustrations and other symptoms of mediocrity are still being widely publicized, the demand for pointed criticism appears to be on the increase.

An example of such a demand was the request from N.B.C. television for a special half-hour program, featuring three of NATURAL HISTORY's children's book reviewers. It was designed to treat the problems inherent for librarians and teachers in judging the vast output of science books today. The program, produced in cooperation with New York University, reached a large audience, aroused a great deal of interest, and was rerun during the summer.

As this issue goes to press, our reviewers and consultants are scheduled to play leading roles in an unusual one-day seminar for teachers, librarians, and publishers to be held at Rutgers University, devoted to an evaluation of books and reference materials intended for secondary school science students. The demand for such a discussion, sponsored by Rutgers and NATURAL HISTORY magazine, is indicative of the current problems and growing interest in this area.

The 1963 coverage of books for young people, like the ones in past years, attempts to accentuate the positive, although our reviewers occasionally find it necessary to dissect flagrantly inferior products. Their reactions appear below under the usual departmental headings. This introduction briefly considers a few of the books that do not fit into their specialized areas.

To start with the physical sciences, *The Story of Cosmic Rays*, by Germaine and Arthur Beiser (Dutton), is a model of the way to present one of the most complex areas of research in an absorbing and direct manner. The emphasis throughout is on basic studies, on science as exploration—an approach that should certainly encourage further reading. The book is so stimulating that the lack of a bibliography is particularly unfortunate.

Accurate information about progress in chemistry may be found in *The Search for the Elements*, by Isaac Asimov (Basic Books), and *The Fabulous Isotopes*, by Robin McKown (Holiday House). (Do not be put off by the gaudy adjective in the latter title.)

As scientific discovery accelerates, there is a corresponding increase in demand for books that deal with recent advances. Margaret O. Hyde helps meet this demand with *Molecules Today and Tomorrow* (McGraw-Hill). Her theme is broad enough to include new work on masers, viruses, the hereditary material DNA, and the possibility of life on other worlds. These diverse subjects are related at the molecular level, and it is a mark of the author's experience and talent that she brings out the relationships clearly. Another good book that covers contemporary ideas in biology, astronomy, physics, and other areas is *The Riddle of Time*, by Thelma and Corydon Bell (Viking).

In recent research, many of the most significant and fruitful studies involve thinking processes—the workings of the brain in health and disease. Some psychological contributions are described in *The Science of Ourselves*, by William McBain and Ronald Johnson (Harper & Row). As professional psychologists, the authors write with authority on what experiments on human subjects can teach us about illusions, the senses, individual differences, learning, and memory. They are enthusiastic about their branch of science—too enthusiastic in one respect, as they fail to indicate that investigators in neurophysiology, psychiatry, and other fields also do a great deal to promote understanding of such matters.

A Short History of Science, by Arthur S. Gregor (Macmillan), reflects the increasing interest in the evolution of the experimental approach. An elementary introduction to work of the past, it is clearly based on considerable teaching experience, and it combines fact and anecdote to outline problems that have confronted scientists from ancient times to the present—problems of freedom *for* research and *from* inquisition, as well as problems of technical understanding. Recent investigations in the history of science provide a rich and largely untapped source of material for future books that would deal with specific periods and developments.

Authors often deserve as much credit for the mistakes they avoid as for their specific achievements. The main point is to inform audiences. To cite only one aspect of this commendable, direct approach, the books above are notably and refreshingly free of the common tendency to write down.

Perhaps the major and most prevalent failing of books on modern science is a certain remoteness from the laboratory, and from other places where exciting developments actually occur. In fact, accounts based on visits to research centers or firsthand research experiences of any sort are so rare that few cases in point come to mind. Yet, the desirability of such an approach seems obvious, because writers who work closely with active investigators make fewer mistakes in text and illustrations. Until such co-operation is the rule, rather than the exception, we shall have to put up with efforts that fail utterly to convey the spirit of research.

At present, progress is so slow that the need for positive action as well as criticism becomes increasingly evident. Of course, protests have helped and will continue to help. As a result of our 1962 survey, for instance, at least one substandard book failed to go into a planned second edition, and a large publishing house established a new panel of scientific consultants to check outlines and manuscripts in detail.

An interesting and useful example of the positive approach would be to produce several "showcase" books, each prepared jointly by an experienced writer and a scientist engaged in research. These volumes would demonstrate to an eager public what can really be done in science book production. In any case, ideas that can be translated into action are desperately needed by publishers as well as by consumers.

JOHN PFEIFFER

Anthropology

IN reading this year's selection of anthropology books I have tried to consider only how well they serve as an introduction to the various branches of anthropology, regardless of the intended purpose. Indeed, it sometimes seems more merciful to omit the question of intent, for in several cases the only discernible intent on the part of publisher or author was to get a book on the stands as fast as possible without thought to quality, make a quick sale, then let it slide into oblivion.

It is difficult not to be impatient with publishers and authors in the field of books for children. Adults deserve what they read, but it is little short of criminal to consider the children's market as fair game for churning out commercial trash under the guise of educational material. Happily, the situation this year is better than in the past in this respect: I found no really bad books, a few that are merely useless but otherwise harmless, and several that are excellent.

In evaluating a book as an introduction to anthropology we may be considering a book dealing with either the inner workings of the discipline or its subject matter. Technically, the first book reviewed here, *Exploration of Africa* (American Heritage), does neither, but I include it because it is an example of how well a non-scientific but professional writer can collaborate with a scientific consultant. This Horizon Caravel book was produced by George H. T. Kimble as consultant and Thomas Sterling as author. It sets out to show nineteenth-century Africa as the explorers saw and recorded it for a public that was more than disinclined to have its pet illusions shattered. I would prefer to have seen included in this volume more material from earlier centuries, dating from Herodotus and the early Egyptians, but perhaps this would have enlarged the book beyond practical bounds.

This work adds nothing new in terms of fact, but because of its elaborate and highly attractive presentation it does fulfill a useful function. Any youngster's imagination is apt to be captured by the colorful reproductions of early maps, prints, and paintings. Each illustration adds to the text rather than duplicating it, and the text tells the gripping story of exploration in a straightforward, if perhaps too uncritical, way. Although the book is about explorers and exploration rather than about Africa and Africans, it can hardly fail to arouse interest in that country and its people.

The other eleven books reviewed adopt a more outwardly academic form. Four deal with archeology and seven are concerned with living peoples. Of the archeological books, *America's Buried Past*, by Gordon C. Baldwin (Putnam) is outstanding. It is hardly surprising that this should be superior, considering the qualifications of the author. And Dr. Baldwin certainly disproves the myth that scientists are invariably poor writers. He arranges his subject matter simply, alternating scientific fact and explanation with descriptive sections based on sound research rather than the commoner, lurid flights of imagination.

Dr. Baldwin disposes of some of the wilder theories about America's past, and as he tells the reader of how much and how little science can say on a given point, he does not hesitate to postulate alternative theories as to where the early Americans came from, how they lived, and why they might have done so. As he does this he explains the scientific techniques used to acquire this knowledge, and gives us a feeling that the scientist's insistence on absolute accuracy is no dull quibble over trivia, but rather an exciting, stimulating challenge.

The other three archeological books are much more general, and might be classified as "useless but harmless." *The Caves of the Great Hunters*, by Hans Baumann (Pantheon), is perhaps the best of the three. It is certainly the best illustrated. It deals with cave paintings and attempts a difficult technique involving a series of "flashbacks" through which the reader is meant to participate in the discovery of some of the famous caves containing prehistoric paintings. This device grows tiresome if the book is read through, but if sampled at random it does, in places, create a vivid picture and conveys the thrill of discovery. For this it is to be recommended.

The remaining archeology books nearly duplicate each other in content and banality, and have little to recommend them. *Portals to the Past*, by Katherine B. Shippen (Viking), is a pretentious book that attempts a history of archeology and archeologists. It succeeds only in giving brief sketches of the least important aspects of the subject. The author frequently evades the consequences of her apparently limited information by claiming that "little is known," although she suggests at one point that archeologists at the time of the discovery of Tutankhamen's tomb "had known all there was to know of Egypt and her past." She seems to assume that her readers will, like herself, display no interest in the hidden meaning and significance of such discoveries, but will be content with the superficialities she presents, sometimes with gross inaccuracy. An example is her statement that early Saharan men "left no traces."

Charles Daugherty's *The Great Archaeologists* (Crowell) is better in that it confines itself to the archeologists rather than their discoveries. But even so, it seems to dwell on the least significant aspects of their lives and works, when there is so much of greater importance that the author could have said, and just as attractively. Considering the competition for a child's time, children's science books, to fulfill their obligations, must be more than just attractive. Every word must count.

An example of completely wasted time and energy on the part of the producers and anyone so rash as to read the book is the Encyclopaedia Britannica's *Sioux Buffalo Hunters*. It consists of gaudy reproductions of scenes from an "educational motion picture," and a text, adapted by Don Russell, that gives the impression that Sioux life went its happy way without any need for organization.

A happy contrast are Robert Hofsinde's *Indian Fishing and Camping* (Morrow), and *Once Upon a Totem*, by Christie Harris (Atheneum). Hofsinde, as always, is clear, factual, and practical. His book tells about Indian fishing and also gives some pointers as to how his readers can learn a few tricks. Although no fisherman, I would be tempted to take a fishing and camping vacation just to try out some of the ideas in this delightful and well-illustrated book.

The author of *Once Upon a Totem* is to be congratulated for having attempted to convey, through several American Indian legends, thoughts and beliefs that must at first seem very strange. In other contexts this would be a mere collection of fairy tales, but as presented by Mr. Harris these legends bring the whole Northwest coast into startling relief. Above all, unobtrusively but pertinently, the basic elements of social organization emerge, particularly as related to the Indian's concepts of life and death. Each carefully selected traditional tale is introduced by a page of explanation that gives more than adequate guidance. This book is a delight to read.

Two books on European peoples are published by World: *Horsemen of the Steppes*, by Walter A. Fairservis, Jr., and *Slavic Peoples*, by Thomas Caldecot Chubb. The latter is disappointing because Chubb consistently displays narrowness of vision that is at variance with the nature of the book. His language betrays this when he talks of the social customs of the pre-Christian Slavs as being "backward" and refers to them as being "close to our savage ancestors." He is even unwilling to accept polygamy as "marriage . . . in the sense which we understand it." Clichés such as "an eye for an eye and a tooth for a tooth" are used to describe the working of Slav justice, which "was swift and ruthless." Customs of the Slavs are described only superficially, without any success in understanding them or in trying to present them as an efficient system that worked and led in a consistent way to the emergence of a distinctive culture.

NATURAL HISTORY presents on these pages its fourth annual survey of current science books for junior and senior high school students. The reviewers are on THE AMERICAN MUSEUM's scientific staff, and John Pfeiffer, who wrote the introduction, is a free-lance science writer of wide experience. Their reviews cover a total of sixty-eight volumes and are designed to present librarians and teachers with a guide through the thicket of available books. The reviewers and editors also hope that these appraisals will prove useful to anyone who is faced with the problem of choosing a good gift book on some facet of natural history.

The Great Auk
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a novel

The tragedy of the great auk

In this unusual novel, Allan W. Eckert dramatizes the final stages in the annihilation of this singular, flightless bird of the North Atlantic, the great auk. The novel's hero (a bird of whom you will find yourself growing very fond) is the last leader of the species who guides the remaining small flock of great auks on their last migration to the Carolina coast and back to Eldey Island off the coast of Iceland.

A book with a mission

"There are many creatures," Mr. Eckert says, "which are now in roughly the same precarious state as the great auks were during that last migration to the south. If some type of protection — and more than merely restrictive hunting laws — is not afforded them immediately, they will, as the great auks did, pass into oblivion."

Thornton W. Burgess says, "THE GREAT AUK is a powerful presentation of a situation that confronts an appalling number of species of wild life today. Mr. Eckert knows his sea birds. His description of their nesting habitat and environment paints a colorful,authentic picture of conditions as they must have been in the time of the great auk tragedy, and still are. This is a book with a mission far greater than mere entertainment."

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Dr Fairservis, happily, knows his job better and launches into *Horsemen of the Steppes* with enthusiasm. Personally, I rebelled against the invitation to participate and fight side by side with the author in some bloodthirsty battle, disguised as "Roman soldiers stationed far from Italy." And I found it difficult suddenly to stop being a soldier and to become a Chinese princess on the same page. As a Cossack I was a hopeless failure; I just don't like horses. However, if you can put up with the vertiginous changes of scene and the "wellsprings of blood that gush hideously everywhere" this is an excellent book—an example of how much better it is when publishers choose qualified authors.

A painful contrast is *Africa—Awakening Giant*, by Sidney Lens (Putnam). It presumes, first off, that Africa was asleep until the intrepid Europeans "discovered" it. At one point Mr. Lens expresses surprise at how quickly Africans have moved from "a tribal way of life to forming a nation." What is really surprising is the author's abysmal ignorance and his nerve in perpetuating so many old misunderstandings while fostering new ones.

According to Mr. Lens, striking a note of paternalistic condescension: "You could not really speak of [Africa] as backward. After all, it was here that the first man was probably born."

He reiterates old claims about the Sahara as a barrier and the unnavigability of Africa's rivers as being responsible for the "fact" that "Africans were isolated not only from Asia and Europe but from each other." This is balderdash. The Congo River, which he says "can be navigated only for short distances," has some 1,900 navigable miles, and as for the desert, it has never presented an obstacle either to mass movements of populations or to the movements of individual trading groups. But "isolation" is indispensable to Mr. Lens's argument, so he creates it, contrary to the facts.

It is a pity that Mr. Lens did not confine himself to contemporary Africa, because the chapters on that subject are better, although still superficial. As it is, the first part of the book completely destroys whatever value the rest of it might have had, and there is a need for a good juvenile book on this subject.

To end on a happy note, *Aboriginal Australians*, by Norman Tindale and H. A. Lindsay (Jacaranda Press), is good, solid, reliable fare, and perhaps closer to a textbook than anything considered above except Baldwin's volume. Tindale and Lindsay give a good historic introduction to the area, going back to the ice ages. But they quickly narrow their field and devote the bulk of the book to describing the daily life of the contemporary aborigines, their economy, notions

A scientist's personal account of life in the wilderness

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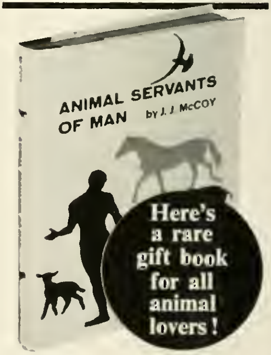

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By J. J. McCOY
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of morality and law and order, their family relationships, and their beliefs. Art and literature are also dealt with as vital and essential parts of a dynamic and living social system, not as isolated facets of an exotic culture.

The illustrations—photographs and drawings—serve a useful purpose. This book, published in Brisbane, Australia, stimulates interest and presents authentic facts. I wish there were more like it.

Colin M. Turnbull

Astronomy

From sundials to rocket ships and from constellations to stellar evolution, the reader interested in the field of astronomy can choose what he will this year. Although books devoted wholly to astronomy are fewer than in past years, they are somewhat better than the previous offerings. Predictably, books about space exploration are more numerous. There are so many facets to this subject that many books can be written with different angles, a welcome situation for publishers. However, since space exploration has much more future than past, most of these books are repetitive in the sections that "lay a foundation" for later chapters. Most then continue on safe ground by outlining immediate plans for exploring the moon. One of the books hits home with a good discussion of the needs of man himself in space, but one shoots off in all directions of speculation.

In my review last year I proposed a rule for selecting a good book on the space effort from the large number available: in lieu of personal knowledge or having read a review, buy a book by an author who is also an authority. This year we encountered the exception to prove the rule.

Many engineers will recognize the senior author of *Conquering the Sun's Empire*, by Frederick I. Ordway, III, and Ronald C. Wakeford (Dutton). Mr. Ordway is a writer of technical works in space technology and is an editor of other serious publications. The engineers may hope that this book will authoritatively answer their children's questions about what they are doing. Unfortunately, the book presents few answers.

The authors set the stage for their ideas of man's conquest of the solar system, discuss such new fields as astrochemistry and astrogeology, and state reasons for establishing observatories in space and bases on other worlds.

The nearer worlds in space would be the first to bow, followed by the more distant ones. Those bodies that pose such technical problems as dense atmosphere or high surface gravity would be the last to be "conquered." The authors first discuss past history and future plans for the conquest of the moon. But, illogically, they discuss the planets, satellites, and

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asteroids in order of their increasing distance from the sun instead of in the order of technical challenges they present.

Problems of landing on and escaping from a planet are considered, but the authors neglect another fundamental point—journeying to and from varying distances from the sun. Propulsion and fuel needed to cope with the sun's gravitational attraction are ignored.

Manned explorations would naturally follow probes, orbiters, soft-landers, and robot rovers. Perhaps, but the authors do not state what known problems will have to be solved—or how. They do say: "Biological sensing devices will determine if any very primitive life, or prelife, forms exist. . . ." What are biological sensing devices? Can they be logically foreseen today? Is knowledge of life itself sufficiently general that principles of operation of such devices can be suggested? Discussing manned landings on Uranus: "for the purposes of our narrative, we shall assume that broad scientific advancements will make the feat possible." It is precisely this fundamental assumption that gives this book the character of poor science fiction. All is laid so far in the future that logical explanations are bypassed. In the absence of scientific transitions to events beyond current understanding, the authors may as well attribute the results to magic.

Unfortunately, much that is within grasp today is treated with a disregard for facts. Exploration of the asteroid belt will be extremely dangerous because of a high probability of collisions. Perhaps one or two asteroids may be investigated out of curiosity, but that "selected asteroids might serve as base sites for communications relays, navigational aids, supply depots, and emergency rescue stations" is preposterous.

There are fifty illustrations in this 125-page book. Only five convey scientific information, although many are beautiful—the artist, Harry H-K Lange, is a fine technician. My over-all impression is that *Conquering the Sun's Empire* would make an excellent illustrated talk at a service club luncheon.

Man and the Space Frontier, by G. Harry Stine (Knopf), is an excellent book; it is unusual that it deals solely with the problems of handling the "software" for space exploration—man.

In an interesting and readable style, Mr. Stine discusses the physical, physiological, and psychological problems faced by man at the space frontier and by the designers of his equipment. Temperature, fresh air, radiation, isolation, even companions, are a few of the topics considered. In most instances the author gives a little of the background of the studies to place them in a modern context. Drawing a parallel with the history of the design of automobiles and aircraft, he predicts that ultimately (this twenty-year estimate seems a bit short) space travel will be as inexpensive and comfortable as air travel, and that "frail little old ladies" will visit the moon and Mars.

Americans Into Orbit, by Gene Gurney (Random House), is one of the Landmark series and is a generally acceptable account of Project Mercury and the seven astronauts involved. This would be a fine book but for one thing—it was written in 1962, long before the project ended. Another problem involves the author's repeated "explanation" of orbital physics as "a balance between gravitation and centrifugal forces" (NATURAL HISTORY, October and November, 1963). Next year might be a good time for a final edition of this otherwise good book.

Martin Caidin's *By Apollo to the Moon* (Dutton) is a timely book by an experienced author. It is easy to read and contains a wealth of information about the Mercury, Gemini, and Apollo projects and their dependence on each other. Mr. Caidin also relates the United States space program to as much as can be learned of the Russian effort. Immediacy and authenticity are achieved by quoting the public utterances of various officials in the National Aeronautics and Space Administration regarding our goals. Although the text shows signs of hasty editing (no distinction is made between *to damp* and *to dampen*), it is well worth reading now, for it will probably be out of date in two or three years.

Planet X is the prediscovery name given to Pluto by Percival Lowell, who was the leading proponent of the existence of such a trans-Neptunian planet. In *The Search for Planet* X, by Tony Simon (Basic Books), the author reviews with clarity the historical and scientific background for Lowell's ideas. The book outlines the deviations of Uranus from a calculable orbit, Adams' and Le Verrier's mathematical search for a disturbing body, the actual sighting of Neptune and the controversy over credit for its discoverery. The further wanderings of Uranus and Neptune, and, finally, the actual search for Planet X. Mr. Simon dramatizes the problems involved by sketching the biographies of the participants in the work, and by introducing as the real hero of the story Clyde Tombaugh. He is the man who actually located Pluto and thus became the third person in history to know he was looking upon a newly discovered major planet for the first time. This book is a fine recounting of these events.

The young reader will be able to construct a sundial and know how and why it works after finishing *Sundials*, by Roy K. Marshall (Macmillan). A brief history of sundials and early timekeeping devices is interestingly presented and should lead many readers to further investigation of the subject. Although the geometry of earth-and-sun relations is somewhat complicated, the author succeeds in presenting it simply. There is an error in the labeling of a diagram that shows the sun's diurnal path in the Southern Hemisphere, but the other illustrations are informative and include some good pictures of early timekeeping instruments. The book closes with complete instructions and cutouts for making a small sundial.

Johannes Kepler, a contemporary of Galileo, lived during troubled times in a turbulent country. All scientists know that Kepler's contributions to astronomy were the basis for much of Newton's work, but few know about his life. This gap can be remedied by turning to *Johannes Kepler and Planetary Motion*, by David C. Knight (Watts). Without resorting to imaginary conversations and guessed-at thoughts, the author succeeds in making Kepler come alive; a person who was often ill, often frustrated, and sometimes elated. In matters of astronomy, however, the author is quite weak. Kepler's important "Rudolphine Tables" are never described, although allusions are made to their significance. A knowledgeable reader will understand the section dealing with relative distances to planets, but others may be greatly confused. And Kepler's greatest law, which relates the distances and periods of the planets, is never shown to be the powerful tool it became (after modification by Newton) for deriving the masses of celestial bodies in orbits. It is surprising that so little astronomy figures in this book, but Mr. Knight's account is a highly readable biography of Johannes Kepler.

It is a simple task to teach beginners the outlines of constellations in a planetarium dome; one can use a specially designed flashlight to point to the stars. Out of doors at night it is more difficult, and, in book form, the task is immense, for it is necessary to convey the concepts of scale and relative directions by words and diagrams alone. Joseph M. Joseph and Sarah L. Lippincott, the authors of *Point to the Stars* (McGraw-Hill), successfully use simple, effective illustrations, and introduce a "little man" who points to the stars in realistic diagrams. The information they have incorporated is considerable, and is not confined solely to the locations of the more than two dozen constellations they discuss. The necessary technical information about the earth-sky geometry and time are adequately presented; in the discussion of each constellation a bit of mythology is presented to satisfy the whimsical, and some interesting astronomical features are mentioned. To probe more deeply than the naked eye allows, the authors have included special objects of interest to be found with binoculars and with telescopes. The reader is told how to discover and identify planets, and even to "point to earth satellites." However, the reader must pay close attention to directions for using the authors' method for locating celestial objects if they wish to find a particular constellation at a specific time of year or from an unfamiliar point on the earth.

This is an admirable work, clean in design and presentation. It should be exactly right for the interested person with no one to help "point to the stars."

In purpose, *Stars and Outer Space Made Easy*, by Carlos S. Mundt (Naturegraph), introduces the reader to the constellations and then discusses what astronomers know about some individual stars, certain types of stars, the galactic system of stars, and the system of galaxies. The author, a professor of astronomy for more than thirty years, presents the material in a practiced manner.

The book does have two shortcomings. Although Professor Mundt has kept up in certain of his fields of interest, he is a bit out of date in others—as evidenced

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in his discussion of stellar evolution and color-magnitude diagrams. And the book reads as if it were transcribed from a series of popular lectures—rhetorical questions and all. Inaccuracies of minor fact are tolerable in a lecture, but in a book they are not. Perhaps a new edition will contain these extensive revisions.

K. L. FRANKLIN

Botany and Ecology

THE thirteen books on botany and general ecology included in this year's review vary widely in subject matter, orientation, and accuracy. These books reveal no distinct trend toward significant changes in scientific quality of natural history books for children. As in the past, some books are excellent while others are extraordinarily poor, and, in general, those that are best illustrated are the worst written.

A personal experience may reveal, at least in part, policies that result in inaccurate popular natural history publications. Recently, a major publisher asked me to review the manuscript of an adult book on forest ecology that had been rewritten for children by a professional writer with little training in biology. I submitted about three hundred criticisms, each citing an error and suggesting a correction. Finally, after working through four more drafts of the manuscript, I received a telephone call from the chief of the publisher's research staff. She told me of a meeting at which the editor of the series had said that the scientific criticisms had "ruined the book" and made it "unreadable."

An outstanding example of a book that refutes the opinion that an accurately written book on forest ecology is consequently uninteresting is John and Jane Perry's *Exploring the Forest* (Whittlesey House). Usually, I do not read through a book for this review at one sitting. However, *Exploring the Forest* is so accurate and so well written that I found myself at the last page almost before I realized it. The reader learns interesting ways of the forest biota, many camping and hiking aids, and some enlightening facts about the work of professional foresters and the wood utilization industries. The material is presented through fictional but realistic stories of hikes and adventures, and nothing is overdramatized. The authors and the publisher may take pride in this extensively researched, lucidly written, carefully edited book.

The most beautifully illustrated books in this year's selection are a young reader's edition of *The Continent We Live On*, by Ivan T. Sanderson (Random House), and a four-volume series on *Our National Parks*, by Frances Wood (Follett). In the latter, seventeen national parks and eighteen national monuments of the western United States (including Hawaii) are described and pictured in color. The texts of Wood's books are almost entirely descriptive and list points of scenic interest, plants, animals, and historic sites with little or no explanation of origins, habits, or significance. The quality of the illustrations is variable—some are exceptionally lifelike, but others are so poor they are almost surrealistic. Over-all, however, the four volumes present a stunning array of the scenery of several of our most beautiful parks.

In the new edition of Mr. Sanderson's *The Continent We Live On*—subtitled "A Special Edition For Young Readers"—Anne Terry White has rewritten and greatly shortened the original text, which was riddled with factual errors and artificial dramatizations of natural phenomena. Most of Sanderson's fabulous tales have been eliminated, as have many of the erroneous interpretations and other errors of the first edition. However, a number of errors persist and greatly reduce whatever value the text might have had as an introduction to the physical geography and natural history of North America. For example, the entire Great Central Valley of California is called "Sacramento Valley"; the geology of the North Dakota Badlands is misrepresented and a weird explanation is given for their coloring; and the Arctic fox is said to be a "foxlike dog." This list could be extended, but let these examples warn the potential reader.

The illustrations in this edition are poorly reproduced compared to those of the original version—the color plates look dull and the black-and-white pictures are of poor tonal range. Nevertheless, the collection of illustrations makes the book a good buy; just leafing through it should imbue the reader with new appreciation of the variety and beauty of the continent we live on.

Two books intended as introductions to the structure, functions, and varieties of flowers could serve instead as guides to poor nature writing. Both brim with teleology and anthropomorphisms; both share the philosophy of predetermination and describe "ultimate purpose" and evolutional "aim." The more disappointing book, because it was written by a professional biologist, is Dr. Ross E. Hutchins' *This Is A Flower* (Dodd, Mead). It is a study in personification and contains recurrent factual errors concerning flower parts and the sexual process in flowering plants. The second book, by Anne Ophelia Todd Dowden, an accomplished botanical illustrator, is entitled *Look At A Flower* (Crowell). If the several biologists she mentioned in the acknowledgments did review the manuscript "with a discerning eye," it is difficult to understand how so many illogical interpretations and Lamarckianisms survived in the final draft.

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The texts differ in orientation. *Look At A Flower* is primarily concerned with what you can see in a flower. *This Is A Flower*, by Dr. Hutchins, is a less intensive description of structural features, but presents more information on flower physiology, including photoperiodic induction of flowering, and evolution. It contains eighty superb photographs, taken by the author, of flowering plants, flower parts, and enlarged views of pollen grains. *Look At A Flower* presents Mrs. Dowden's attractive sketches and clear diagrams of floral structure and variety.

Unfortunately, despite the fine illustrations in these two books, their perpetuation of teleological philosophy makes it impossible to recommend them to anyone seeking an accurate introduction to the study of flowering plants.

Elizabeth S. Helfman's *Land, People, and History* (McKay) is a historical study of soil erosion produced by agricultural activities from prehistoric to modern times, with a commentary on land ownership patterns and considerations of urban and other non-agricultural land uses. After a clumsy opening marred by several anthropomorphisms, the author reaches the firmer (and obviously more familiar) ground of history. She then presents a well-integrated, easily followed story of the almost unavoidable waste of the soil that was a consequence of man's efforts to control his food supply by cultivating plants. The development of modern erosion control in the United States and the growth of the Soil Conservation Service are covered in a biographical account of Hugh Bennett's efforts to alert America to the wastefulness of its agricultural methods, and a description of the rapid growth of federal erosion control research and ensuing recommendations. A timely chapter on wilderness areas presents a plausible and unemotional view of the great value of such lands now and their still greater potential value to generations yet unborn. This book tells a vital story well.

ANOTHER book with a historical view of natural history is Will Barker's *Wildlife In America's History* (Robert B. Luce), a miscellaneous collection of anecdotes about mammals, birds, fish, reptiles, and insects. The book emphasizes man's use and abuse of animals, rather than the animals themselves. The organization is poor and the reader will find it hard to detect any unifying concept or consistent approach from one section to the next. The few chapters that do convey pertinent and substantial information may or may not be judged of enough value to justify buying the book.

Exploring with the Bartrams, by Ann and Myron Sutton (Rand McNally), is a biography of John Bartram and his son William, two of colonial America's most widely traveled and scientifically pro-

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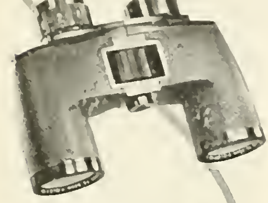

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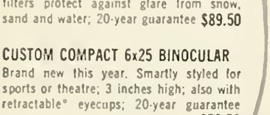

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ductive botanists. The Suttons' information was drawn largely from Francis Harper's scholarly writings on the lives and travels of the Bartrams, but the more adventurous aspects of explorations are highlighted in this book. There is little explanation of the less exciting cataloguing and description that constituted the lasting value of the Bartrams' work. However, the Suttons' book is appealing in its exposition of the personal difficulties and adventures involved in early scientific exploration in eastern North America. Clear maps and interesting pen sketches complement the text.

Conservationists And What They Do, by C. William Harrison (Watts), is an up-to-date career guide. It introduces the reader to the problems created by centuries of unwise use of the world's resources (emphasizing North American problems), and then describes the work of soil, range, and fishery specialists, foresters, and wildlife managers. Each profession is dramatized by a brief story of a "man on the job," and the varied educational requirements of each profession are described. Universities offering career training are listed, or sources of more detailed information are given. This authoritative, encompassing book will be a welcome guide to the high school student who would like to pursue some aspect of conservation as a career. The book has even broader value, however, for it presents many of the conservation problems facing our civilization, relates many principles that must guide us in finding solutions, and summarizes the main currents of contemporary work in basic and applied research on conservation problems.

The trees of North America, from the coconut palm of balmy seashores to the saguaro cactus of our hot, arid Southwest, are the subject of *The Study Of Trees Made Simple*, by Solveig P. Russell (Doubleday). This paper-bound book is illustrated with more than a hundred pen outline sketches of leaves, fruit, tree shapes, and other subjects. Not all of the trees discussed in the text are illustrated, and not all of the illustrations are sufficiently detailed or accurate for positive identification of a tree, particularly the pictures of tree shapes. The text is quite variable in quality. The descriptions are standardized and agree with similar ones published in many other identification manuals. Geographical ranges are given, but for many species the ranges indicated are incomplete or inaccurate. The poor introductory and concluding chapters are particularly objectionable because of a lack of comprehension and several serious factual errors. This book is not as useful, not as complete, and certainly not as accurate as several other recently published paperback books on trees.

JACK McCORMICK

Geography, Geology and Paleontology

BOOKS on science, whether or not th are written for children, can b placed in one of two categories: thos that tell "All About" a subject, an those that tell of "Great Lives in Sc ence." Clearly, both types are impo tant. The younger child usually prefe books in the former category; he woul rather revel in a catalogue of natur wonders than follow the personal trib lations of some long-dead savant.

Books of the "Great Lives" type, i which the progress of one man gatherin and interpreting scientific data is fo lowed historically, have several virtues Interest can be sustained with pertine anecdotes, and the reader can follow th path of logical development traced b the scientist. However, the primary a vantage of this approach is that th nature of science as a cultural phenom non is conveyed in an unconscious an effective way. Science, after all, is not static body of fact and italicized law is a dynamic search for an improved u derstanding of natural phenomena, co ducted by real people. Its only constan character is change. But these biogr phies also have shortcomings: their pe spective is often limited, and their forma is often unappealing.

Books reviewed below include ex amples of the All About and the Grea Lives categories, as well as some tha combine the two approaches.

The Quest of Captain Cook, by Mill cent E. Selsam (Doubleday), is an out standing biography of an importan oceanographer, Captain James Cook The subject of the story is ideally suite for presentation to young readers. Risin from the ranks of the British Navy, Coo won fame and fortune, made great con tributions to our knowledge of th oceans, lived a life of high adventur in remote and romantic places, and le his mark on a variety of disciplines fro public health to anthropology.

The story of James Cook's "three grea voyages around the world" is "the great est single quest any man ever made t explore uncharted waters. . . ." Thes voyages "mark the dividing line betwee the dauntless ocean adventurers of th preceding centuries and the systemati exploration of the earth . . ." The book is highly recommended.

Another fine biography of an important oceanographer and marine biologist is *Pioneer Oceanographer Alexander Agassiz*, by Beryl Williams and Samuel Epstein (Messner). Louis Agassiz, father of Alexander, had such a remarkable career as a scientist that the son's reputation has, to a considerable extent, been overshadowed. Although this book focuses on Alexander's life and work,

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the authors make good use of the contrasts between father and son in bringing alive their controversy about the merits of Darwin's theory of evolution.

Like Cook, Alexander Agassiz provides good copy. Owing to financial difficulties he interrupted his career as a scientist to become a millionaire. Returning to his scientific career, Agassiz brought with him not only money to finance his work (and that of others) but also engineering skill that enabled him to make important advances in equipment for exploring the ocean depths. Agassiz' career thus illustrates the important point that science is an activity requiring not only intellectual skills but also adequate financial resources and proper equipment.

DESPITE its title, *The Case of the Missing Link*, by Eleanor Clymer (Basic Books), is an outstanding book on the evolution of man. It combines the best features of the All About and Great Lives presentations. Human interest is achieved by telling parts of the stories of men who contributed substantially to our understanding of the origins of mankind: Darwin, Fuhlrott, Dubois, Black, von Koenigswald, Broom, and others. The reader will derive a sense of excitement from following an intellectual adventure. The author explains the contribution of stratigraphic geology to the study of evolution by describing the pioneer work of Hutton and Smith. The age of the earth is treated in similar fashion, and the reader learns of the long intellectual struggle that has marked man's efforts to comprehend the vastness of geologic time.

In Prehistoric Seas, by Carroll Lane Fenton and Mildred Adams Fenton (Doubleday), is a good book for younger readers. It describes most of the important types of fossils that record the nature of life of ancient seas. The book is organized systematically by type of fossil, with the recurrent pattern of one or two simple pages of text accompanying excellent drawings and photographs of each major animal category. Although little attempt is made to interpret the facts that are presented, the volume achieves its purpose by providing information about, and stimulating interest in, the relicts of ancient marine life.

Walter Sullivan's *Polar Regions* (Golden Press) is a very brief but very competent survey of the geography, climate, and life of the polar regions. It includes an abbreviated, accurate review of the adventurous story of polar exploration and has informative maps and illustrations, many of which are in color.

Heroes of Polar Exploration, by Ralph K. Andrist (American Heritage), is an excellent, rather detailed study of the history of polar adventures. Staff work by the editors of *Horizon* is clearly evi-

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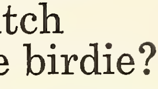

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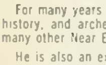

Dr Cyrus Gordon has served as an archeologist on many expeditions in the Near East. He participated in unearthing the royal tombs at Ur, in discovering the mines of King Solomon, and deciphering the Tell el-Amarna tablets found in Egypt.

He is the author of many books and articles on the ancient East Mediterranean. Among the books are **Adventures in the Nearest East, The World of the Old Testament, and Before the Bible: The Common Background of Greek and Hebrew Civilization.**

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dent in the high quality of illustrative material. Striking but familiar polar photographs are supplemented by reproductions of many little-known paintings, woodcuts, and drawings, all assembled with the professional skill familiar to readers of *Horizon* and *American Heritage*. Beginning with the discovery and settlement of Greenland by Eric the Red, the story is carried forward to the voyage of the *Nautilus* under the North Pole. Scientific aspects of polar exploration are glimpsed only in passing. The book was apparently produced with all age groups in mind and is so well done that youngsters twelve and up will enjoy perusing it.

Patricia Lauber has attempted to present the "big picture" of the earth, the oceans, and the atmosphere, as now understood by geophysicists, in *All About the Planet Earth* (Random House). Details such as the origin of local landscapes are left out, and space is devoted instead to isostasy (gravitational equilibrium of earth's crust), heat flow, earthquakes, volcanology, gravity studies, sunspots, ocean currents, submarine topography, wind systems, geomagnetism, cosmic rays, and the Van Allen radiation belt—all in approximately eighty pages of large-print text. The result is of mixed quality. On some topics, such as submarine landscape features, the text gives interesting information and a good statement of scientific opinions regarding origins. In other areas, such as isostasy, the information is badly garbled. Far too much is attempted, and lacking the discipline and outline structure of a textbook, this presentation is often confusing.

An entirely inadequate presentation of scientific material on the study of caves is presented in *The Complete Book of Cave Exploration*, by Roy Pinney (Coward-McCann). Half the book is devoted to the lore of caves—including descriptions of famous caves, discussions of cave animals, and the use of caves as homes by ancient man. The last half is devoted to methods and equipment used in cave exploration.

Presumably, the book is intended for anyone old enough and adventurous enough to plan a caving expedition. Although most of the information is taken from reliable sources and is accurate, some parents may question the author's wisdom in giving young readers certain types of advice. For example, if difficulty is encountered in extricating an injured person from a tight spot, the reader is advised that he "may find it helpful to break one or both [of the injured person's] collar bones with a *piton* hammer or sharp rock."

Stars Mosquitoes and Crocodiles, edited by Millicent E. Selsam (Harper & Row), is an account of the American travels of the great German naturalist Alexander von Humboldt. The story is presented almost entirely in the scientist's own words, with short introductory and transitional passages provided by the editor. Humboldt contributed much to scientific fields of knowledge in the late eighteenth and early nineteenth century and his life was an adventurous one. Unfortunately, the scientist's personality is unlovable, and his writing style pedantic, so that, through no fault of Mrs. Selsam, the book drags. A volume reviewed last year in these columns, *The Dragon Tree*, by Val Gendron, uses far fewer of Humboldt's own words and provides the young reader with a really interesting and comprehensible account of the life and work of this great man.

All About Mountains and Mountaineering, by Anne Terry White (Random House), is a good account of mountain lore and of mountaineering as a sport. However, mountains as objects of scientific study are almost ignored.

John Imbrie

Zoology

A fine selection of zoology books awaits the young reader this year. There are books with magnificent photographs and delightful stories concerning interesting animal groups. Some will fire imaginations while answering questions; others will charm, entertain, and, with great subtlety, inform. But there are also books that are dull, pedestrian, and pedantic. However, this is by far the best collection I have seen since the inception of this children's book survey. It encourages one to believe that authors and publishers are heeding earlier criticisms.

I have always decried anecdotal tales as being unscientific and too anthropomorphic; many are. But I think the two books reviewed below, although highly personal accounts, are informative and stimulating. They do more to encourage young naturalists than the sometimes dry books on zoological subjects.

The Otters' Tale, by Gavin Maxwell (Dutton), is his *Ring of Bright Water* adapted for children. The adult book is the widely acclaimed story of the otters Mr. Maxwell kept as pets. In this revision the writing is unfortunately complex although it is simplified when compared with the original. But if the young reader is willing to read slowly and carefully the end result is worth the effort. The story still retains its sense of suspense, and readers will meet three captivating animals cavorting through the pages, their many moods marvelously recorded by photographs.

The other book, *Silent Visitor*, by Theodore Brauner (Atheneum), is a tale of twelve nights filled with mystery. The author retraces, night-by-night in diary form, the excitement and challenge created by an unknown visitor that was eating bananas in his kitchen. Mr. Brauner,

The loneliness of a little girl

Her name is Patricia Bright Eagle, a forgotten child with a proud tradition. Patricia's home is made of mud and sticks; her food consists mainly of fried bread and corn.

Like other six-year-old children, Patricia started school this year. It was a frightening experience for her. Unable to speak but a few words of English, Patricia suddenly found herself in a world where she became self-conscious and ashamed of her clothes, of her name, of her appearance...of herself. She stays apart, bewildered and lonely.

Patricia will soon learn to speak English, but there are some things school cannot give her, things that the other children have. She needs new shoes, decent clothes, money for school activities and school supplies—and for an occasional luxury such as a bracelet or a small toy. She needs the help of someone who cares... someone to give her the confidence and assurance she needs so desperately to participate in voluntary school and community services.

If not you...who?

You—or your club or office group—can give these things to Patricia or another needy Indian child through SAVE THE CHILDREN FEDERATION. Your contribution of just $10.00 a month, $120.00 a year, will provide a child with funds to buy suitable clothing, books and a cash allowance for school activities.

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a photographer, rigged up a camera system whereby his nocturnal visitor would trip a release and take its own picture. And thus Mr. Brauner discovered that a bat, carrying a baby bat, fed on the bananas in his fruit bowl. This led the author into a search for bats in their natural habitats and to an inquiry about their biology. It is a wonderful book, filled with unusual, revealing photographs, and written in an easy, smooth style, with delightful touches of humor.

Other books that deal specifically with mammals are about weasels, whales, and dolphins. C. B. Colby's *Fur and Fury* (Duell, Sloan and Pearce) concerns the family Mustelidae—the weasels, ferrets, minks, martens, fishers, otters, and skunks. Each chapter describes a separate species, giving its life history, habitat preferences, hunting behavior, maternal behavior, and behavior of the young. Photographs show members of each genus. Although the book has no index and I found the writing occasionally trite and anthropomorphic, it is a competent work and should appeal to the child interested in this family.

The Remarkable Dolphin, by Henry Chapin (Scott), is also a competent work. This is a standard report with an index, list of references, and an impressive roster of scientists whom the author consulted about dolphins. It is illustrated with good pen-and-ink drawings. Mr. Chapin opens with a general description of dolphins, and points out that he will be describing *Tursiops*, the Atlantic coast dolphin. The first chapter is an introduction to the subjects covered in the book, such as anatomy, physiology, behavior, and mythology. Then the family life of the dolphin is charmingly described. A long chapter on dolphins in captivity at various marine showplaces and laboratories mentions the vast number of tricks dolphins learn to perform in captivity. The information is up to date and includes studies by Kellogg on the echo-sounding of dolphins, and recent work on the dolphin skin, which is now known to increase swimming efficiency.

Mr. Chapin should be congratulated on his caution when discussing the ability of dolphins to talk with humanoid speech. However, he does recognize their ability to learn quickly.

My favorite of these three books is *Killer Whale!*, by Joseph J. Cook and William L. Wisner (Dodd, Mead), a fine book written in a clear, exciting, and informative style. An excellent selection of photographs and drawings enhances and extends the text. Whales are introduced in the first chapter and the remainder of the book is devoted to the killer. The killer whale is well designed for its destructive life. These whales travel in packs, and can destroy other whales many times their size. The killer whale's biology and behavior, feeding habits, and methods of attacking prey

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are described. It is a truly ferocious and frightening beast. The book makes fascinating reading and includes an index.

Although it is delightfully breezy, *How Smart Are Animals* by Helen Kay (Basic Books), has a misleading title. This reader assumed that it would be about intelligence in animals. Instead, it is a book about animal behavior and includes studies on imprinting in animals, communication, conditioning, parasitic behavior in birds, and I.Q. in animals. The subjects are well handled, albeit superficially. There is an index and a list of books for further reading (some are college level texts), and many pictures. The book is well done and accurate.

ANOTHER animal behavior book, *How Animals Live Together*, by Millicent E. Selsam (Morrow), is a survey of various groups of animals that live in great and small groups. The book describes the many ways animals live in harmony: some live in groups only temporarily, when they migrate, reproduce, or hibernate, while others live in groups all their lives. The striking feature about social or group behavior is that it is distributed throughout the animal kingdom. Many diverse groups are discussed, ranging from insects to chimpanzees. There are descriptions of the mating behavior of gulls and penguins, and of the peck order of chickens, a seemingly cruel system that is necessary to the social stability of the group.

Up-to-date reports on the social life of mammals and family groups of primates are included, as are the well-known social orders of ants and bees. The book is accurate and informative—there is a good reference list and index—but I found the writing dull. I also had an uneasy feeling that Mrs. Selsam was implying that animals direct their action with knowledge of their goals, rather than responding to immediate cues and past experiences.

Two soft-covered, textbook-like publications on birds and fishes are new additions to Doubleday's "Made Simple" series. Of the two, *The Study of Fishes Made Simple*, by Eugene V. Mohr, is the better one. It is concerned with approximately 150 fairly common species of fish found in rivers, lakes, and the sea. The author is clever to restrict the number of fishes he wishes to describe, and he does not attempt to generalize from one to many species. The common fishes of lakes and rivers, of coral reefs, of the open sea, and the abyssal fishes are discussed in terms of their feeding and their general habitat. The anatomy of a fish is illustrated, but the function of the lateral line is incorrectly listed as a temperature receptor. The writing is neither too technical nor too simple. Unfortunately, the illustrations are very poor and are rendered in diagrammatic fashion.

In contrast to this largely adequate book, *The Study of Birds Made Simple*, by Hilda Simon, is mediocre. It suffer from an extremely uneven writing styl At one point the author tells stories to six year old; at another she is talkin about birds to an ornithologist. The wri ing is dull and the descriptions of bir behavior are anthropomorphic. Th chapter on migration implies that w understand all the factors that give ris to migrations. There is also widesprea use of the questionable concept of "in stinct." The book is so dull that it was real effort to read it, and I fear that th contents will not matter to the reader

The Giant Golden Book of Birds, b Robert Porter Allen, designed and illus trated by Arthur Singer (Golden Press) is a handsomely illustrated survey o birds of the world. The common name geographic location, and size of a bir are listed with each illustration in colo Many pictures show the birds in action thus reducing the amount of descripti material in the concise text. Dramati looking tropical birds, penguins, shor birds, frigatebirds and storks, thrushes finches, warblers, and starlings, to nam but a few, are covered. This presentatio should help children to discover mo about birds by watching them.

Naming Living Things, by Sarah R Riedman (Rand McNally), aspires to b a book on methods of taxonomy an classification. I thought that, at last, young reader would have a source of in formation about classification and sys tematics and about how scientists decid a group of animals is a separate species It is a difficult subject, and one that i not too well understood by youthful stu dents of biology. However, the autho soon loses sight of her mighty goal an slips into a rather pedestrian survey o the plant and animal world. She lists th major groups of animals and their gen eral characteristics. In some places sh uses simple language, in others, comple language. For example, she tells of fishe "bony and cartilaginous." Why not us the proper scientific names here insteac of the so-called simple names? Also, how is one to know what a class is, or an order, or a family? These points are not clarified in the text, although the autho does discuss genera and species. The illustrations are sketches in a fairly common style. There is an index.

Animals in Science (McGraw-Hill) is Margaret O. Hyde's answer to antivivisectionists. She presents, in direct and lucid fashion, the role that animals play in scientific research and the significant advances in medicine, particularly, that have been made through studies on animals. Although the book is meant for children, many adults who have questioned this aspect of research will find the book very informative. The author describes studies on germ-free animals, on animal astronauts, on animals that can regenerate new limbs, on animals and mental drugs, on animals and polio, on sound and light production, and on genetics and behavior. It is a good work, accurate and up to date. Margaret Hyde should be congratulated for tackling areas of study that most children's authors shy from. The illustrations are adequate. and a bibliography, an index, and a list of biological supply houses where one can obtain animals are provided.

Our World Underwater, by William M. Stephens (Lantern Press), is a very good book on skin diving. Mr. Stephens' attitude is positive: Skin diving can be great fun but one should be sensible about it and know how to handle oneself underwater. He points out that trying to hold one's breath longest or attempting depth records is a sure form of suicide.

The first three chapters deal with the history of diving, the development of self-contained underwater breathing apparatus (scuba), and how to become a scuba diver. Mr. Stephens then tells of hair-raising shark hunts, of ways to photograph underwater and what equipment to use, of cave explorations, of treasure hunting, and of wreck explorations. The photographs are very good and there are some amusing sketches. The book ends with an excellent, long bibliography.

In brief, here are three insect books. *Wonders of the Beetle World* by Sigmund A. Lavine (Dodd, Mead), is about beetles and the role they have played in the culture of man throughout history. The Egyptians made sacred scarabs in the form of beetles to signify everlasting life. Ladybug beetles are a popular element in folklore. The author describes, in an interesting and pleasant style, mating behavior, beetle development, and the various beetle specializations.

Insects and Plants, by Elizabeth K. Cooper (Harcourt, Brace & World), outlines the relationships between insects and plants, including nectar-gathering, pollination, the use of plants as homes for developing insects, plants that eat insects, and insects that eat plants. The book has a good index and is well written, although the author has a tendency to imply purposefulness in the behavior of both insects and plants.

The most attractive of the insect books is *A Bee is Born* (Sterling). The photographs by the author, Harald Doering, are excellent in all respects. They are informative, clear, aesthetically appealing, and numerous. Each appears with a fully explanatory caption. Mr. Doering has organized his book into various chapters, and he lucidly describes the birth of a new colony, the worker bees, the queen, the hive, and the many specialized activities of the colony. There is a spectacular photograph of a bee in the process of stinging the author's finger, and an equally superb series of photographs of the queen as she emerges from her cell.

Exploring Biology, by Tad Harvey (Doubleday), left me somewhat confused because the text is appropriate for students in high school or beyond, but the magnificent and profuse illustrations by Lee J. Ames are largely designed for children. The author opens with a general story on ecology, morphology, and cell physiology. Ultimately, and I think that this is the point Mr. Harvey was trying to make, he explores the work of biochemists and biophysicists as the final goal in the study of biology. Many biologists will disagree with that view.

The material presented is what one finds in a standard biological text. I believe that Mr. Harvey's noble intent was to show that the entire field of biology is related, from a single amino acid to the evolution of man. However, I do not think that his attempt was successful.

EVELYN SHAW

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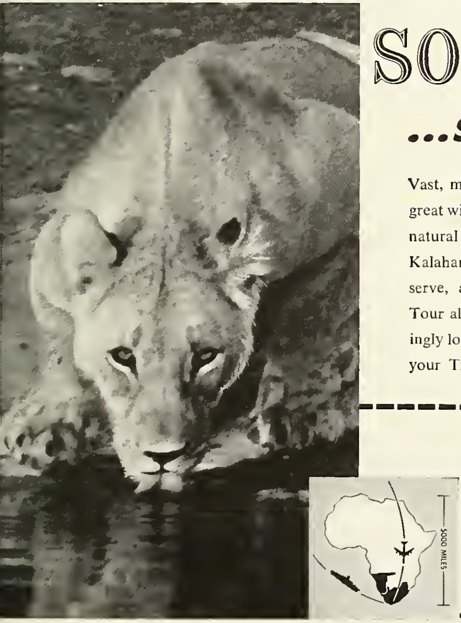

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Digs Expose Ancient Lydian Capital

Rise and fall of urban patterns seen in once-wealthy Sardis

OPENINGS to tunnels constructed by Sardis engineers, in center, *left*, were revealed as concealing rock fell away.

MIGHTY WALL at south slope of Sardis citadel was built in the Early Byzantine period entirely from earlier buildings.

By George M. A. Hanfmann

The peninsula of Asia Minor, which is modern Turkey, is a bridge between two continents and has played an important part in the history of civilization. Recent discoveries show that already in the sixth millennium B.C. early agriculturists were building villages in Central Turkey (Çatal Hüyük near Konya). The mineral riches of eastern Turkey were responsible for important technological advances during the Bronze Age and subsequently the great culture of the Hittites arose in the mountain-rimmed highlands of the interior (*see* Natural History, June-July, 1959). Slashed from east to west by drainage basins of several big rivers that run to the sea, the western part of Turkey has been at all times the meeting ground for Mediterraneans and Near Easterners, for sailors coming across the seas, and for caravans descending through the river valleys from the interior. Systematic work on the history of this zone of contact began with H. Schliemann's sensational discoveries at Troy, but despite numerous excavations much remains to be learned, especially about the early cultures of the area. High on the list of promising objectives is Sardis, which at one time in its history was the richest city in the world and the capital of a great kingdom.

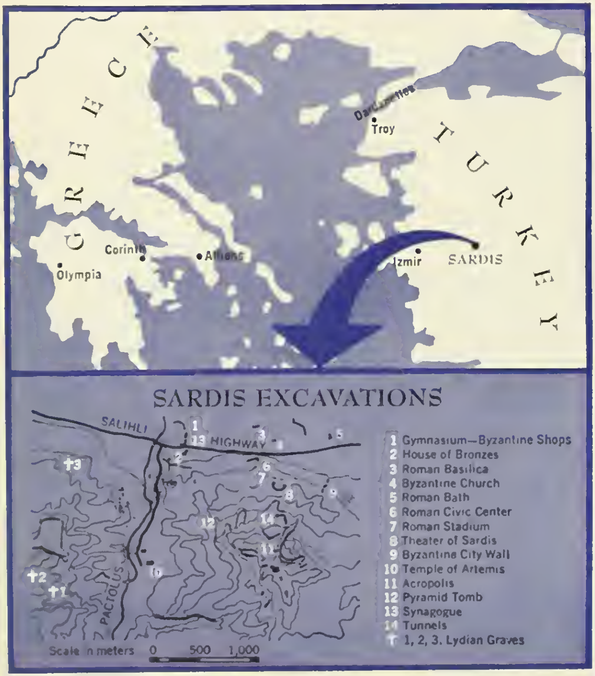
Some sixty miles inland from the west coast of Turkey, the picturesque red crags of the citadel of Sardis rise against the backdrop of mighty Mount Tmolus (*ca.* 7,000 feet high). The city lay at the southern edge of a broad, fertile plain formed by the river Hermus (Gediz), after it breaks out of the volcanic region to the east, the so-called Burned Lydia. At the north edge of the plain is a large lake that abounds in fish and fowl. A limestone ridge alongside is dotted with the "Thousand Mounds" (Bin Tepe) of the royal cemetery. Hot sulphur springs attest continued volcanic activity, and earthquakes are frequent. Because the Tmolus keeps its snowcap well into the summer, the region is well watered and is famous for its vineyards and fruit orchards.

Such an environment would be a logical place for early farmers to settle. Flint tools and polished celts were picked up when the railroad from the coast to the interior was built in the 1880's and may be implements of Copper or Early Bronze Age farmers.

In the second millennium before Christ, Hittite kings speak in their annals of a great kingdom named Assuva in western Asia Minor. Some scholars believe that the word *Assuva* is the same as the name of the continent, *Asia*. The Greek historian Herod-

Deeply buried stone funerary chamber was constructed by Lydians *ca.* 600 B.C.

Roman and Byzantine buildings were erected over earlier settlements. At the right are A.D. 400 Roman mosaics; at left, 5th-century B.C. Persian remains.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HIGHWAY
PACTOLUS
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2 House of Bronzes
3 Roman Basilica
4 Byzantine Church
5 Roman Bath
6 Roman Civic Center
7 Roman Stadium
8 Theater of Sardis
9 Byzantine City Wall
10 Temple of Artemis
11 Acropolis
12 Pyramid Tomb
13 Synagogue
14 Tunnels
✝ 1, 2, 3. Lydian Graves
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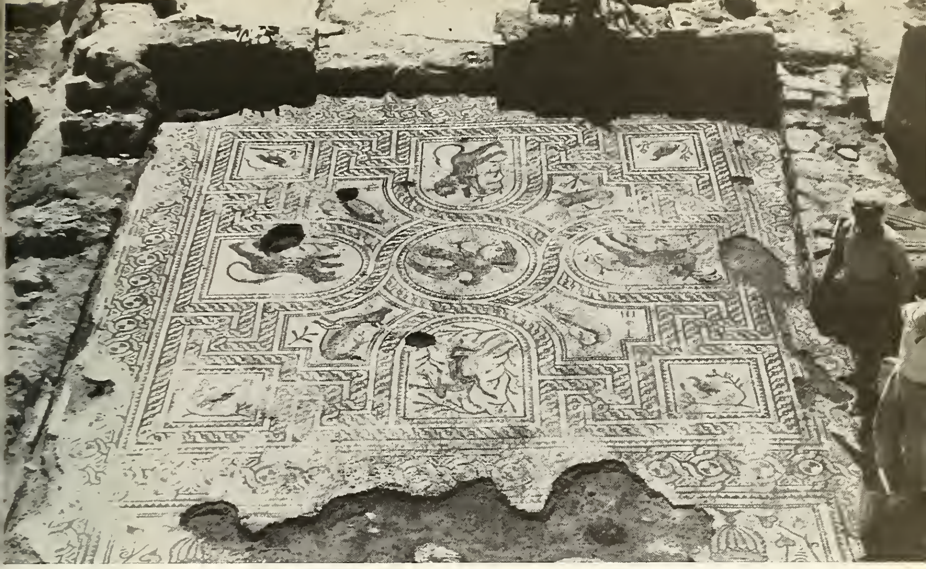
otus contended that this name originated in the vicinity of Sardis.

Various Greek legends concern themselves with the region. Thus, the Greek hero Pelops was supposed to have come from Sardis to Olympia in Greece, where he instituted the chariot races of the Olympic games. Sons of the Greek hero Herakles were said to have seized rule over Sardis in the twelfth century before Christ. Even more controversial is a story that part of the population sailed to Italy, where they called themselves Etruscans and founded a number of city-states.

One thing is clear from classical Greek writings. At some time during the Early Iron Age (*ca.* 1100-800 B.C.) the people of the region came to be known as Lydians and their country as Lydia. Although as yet imperfectly known, the Lydian language was Indo-European and, according to many linguists, may be related to Hittite.

In the seventh century before Christ, Lydia emerged into the limelight of history. King Gyges, founder of the great dynasty of the Mermnadae (687-547 B.C.), seized various Greek cities along the coast and interfered in the struggle between the Egyptians and Assyrians in Egypt. Assyrian chronicles relate that an embassy from Gyges came to Assur, one thousand miles



Splendid floor of Roman period is in an amazing state of preservation. At the center of the design is an eagle; a lion chases a stag and a leopard pursues an ibex in the four large medallions that dominate the remainder of the ornate design.

from Sardis. Under his successors, Alyattes and Croesus, Lydia became a world power. Lydians fought the Iranian Medes in the interior of Anatolia and extended their grip to the Dardanelles. Profiting by the low marshlands of the river valleys, the Lydians bred fine horses, and their cavalry became famous. They supplemented their armies with mercenaries hired from mountaineer tribes to the south.

A gold strike and the invention of coinage made possible this meteoric rise of Lydia. During the reign of King Gyges (687-652 B.C.) gold was discovered near Sardis, according to ancient writers, in the sands of the torrent Pactolus, which flows west of the citadel. This has been denied by some contemporary scholars, but a recent study by a Turkish geologist has proved that traces of gold occur in the alluvium.

The original yield must have been very rich. King Croesus (565-547 B.C.), whose name became proverbial as that of the richest man in the world, gave to the Greek oracle of Apollo in Delphi four ingots of gold, 113 ingots of electrum (an alloy of gold and silver), a golden lion, a statue of a woman, an enormous gold bowl, and many other gold vessels, and he made similar presents to other sanctuaries. Although these bonanzas may have served to induce the gods to make the oracles favorable to the Lydian kings, they also illustrate a dilemma of ancient gold owners—there was no way to use gold except as ornamentation or treasure. An unknown genius at the court of the Lydian kings found a brilliant solution for the surplus of precious metals, which included silver as well as gold, by inventing coins.

The earliest Lydian coins were lumps of electrum struck with the royal coat of arms—the fore parts of a bull and a lion. They belong to the late seventh century before Christ. Croesus improved upon the invention by minting several different sizes of gold coins and a series of silver coins. A system of definite fractions of a gold piece and a definite ratio between gold and silver pieces enabled the merchants to rely on this portable, guaranteed medium, and to "make change" much more readily than in barter transactions. Some scholars think that the Lydian kings invented coins to find an easy way of paying their foreign mercenaries. In any case, an immediate result was an enormous quickening of trade, and Lydians became the leading businessmen of the Mediterranean world. As that world increasingly accepted and imitated their coinage, they splurged in a manner that was to be remembered for centuries. Lydian luxury, Lydian fashions, Lydian perfumes, and Lydian cooking were envied and admired by their Greek neighbors. Although grave robbers have been emptying Lydian graves for two and a half thousand years, enough was found by the First Sardis Expedition (Princeton University, 1910-1914 and 1922) in two graves to show that the dead were buried clothed in garments hung with little gold plaques and laden with gold pins, bracelets, and necklaces.

Perhaps pardonably, the Lydian kings imagined that gold could buy everything; yet when the Persian King Cyrus attacked, Lydian power collapsed like a house of cards. Defeated in a battle in the interior, King Croesus fled to his citadel at Sardis. Somehow the Persians found a weak spot in the defenses. One story has it that they saw a Lydian soldier climb over the wall and retrieve his helmet at a place that they subsequently managed to scale; another that the king's daughter betrayed the castle. Croesus died (547 B.C.); his treasure and his capital fell to the Persians, who were establishing themselves as sovereigns of an empire from India to Egypt.

The Persian kings were well aware of the importance of Sardis. King Darius made it the western terminal of the famous Royal Road from the Persian capitals of Susa and Persepolis, through Mesopotamia and Asia Minor to the Mediterranean littoral. The governorship (satrapy) of *Sfard* was one of the most important, and was sometimes held by a relative of the king. In 499 B.C., the Greeks made a surprise attack on Sardis and burned down the city, but could not capture the citadel. This was the beginning of the great wars between Greeks and Persians. Here at Sardis, King Xerxes mustered a great army, which embarked on an abortive attempt to conquer Greece (480 B.C.). Initially, the Persian kings carried Lydian craftsmen to work on their palaces in Iran. Purple rugs from Sardis adorned the royal audience halls. The province had to pay a large tribute, and the royal mint was taken over to strike Persian royal coinage. Jewelry and gems identical with those found in Iran have come from graves of Sardis. Evidently the satraps maintained local workshops, but had them work in Persian style. Gold was apparently still abundant, and many of the bribes the Persians used to set the Greeks against each other may have come from Sardis.

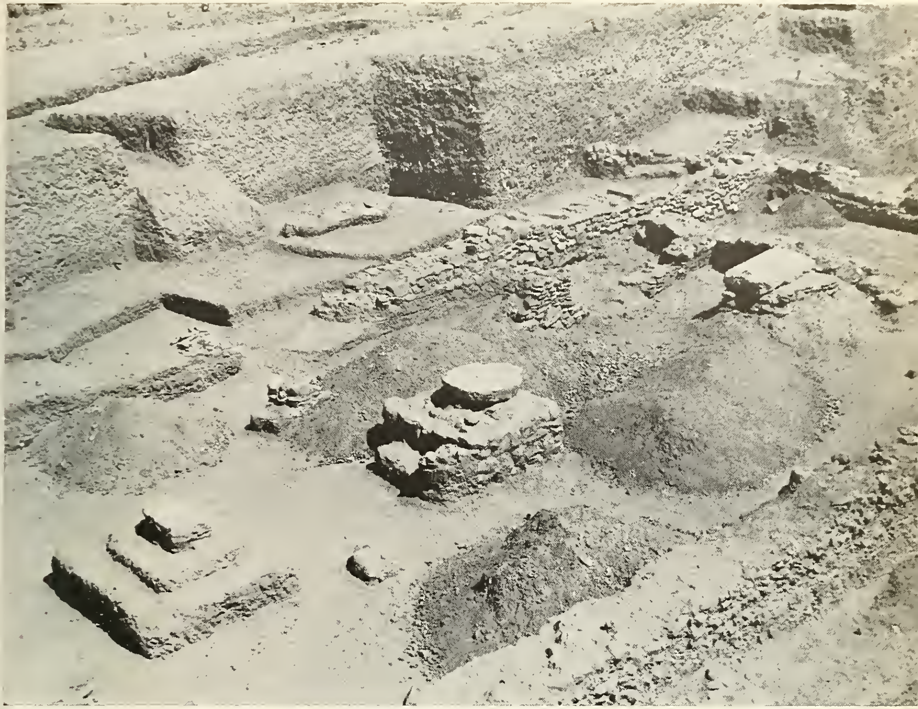
ON the other hand, the Persians did not seek to destroy the native traditions; Lydian language continued to be used and the Lydian sanctuaries were respected. The most important document for our knowledge of the Lydian language comes from this time—a stone burial slab that is inscribed both in Lydian and in Aramaic, a Semitic tongue used by the Persians as the official language of administration in the western part of the empire.

The scales of history were tipping toward the West. After some two hundred years of Persian rule (547-334 B.C.) Sardis fell to Alexander the Great and his Macedonians, and Greek soldiers were encamped on the same plain from which Xerxes had launched his attempted conquest of Greece. The Greek kings, descendants of Alexander's generals, fought for Sardis, only to relinquish the city to the rising power of Rome (133 B.C.). Within a century of Alexander's conquest, the Lydian capital had become a completely Greek city with a Greek constitution and such typically Greek facilities as a gymnasium, a stadium, and a theater. The marble quarries were used on a vast scale. One of the largest Greek temples known was built there to the goddess Artemis. It was excavated between 1910 and 1914 by the Princeton expedition.

EARLIEST EVIDENCE of a settlement at Sardis was found in this Bronze Age jar containing a cremation burial. It was buried 35 feet below the surface.

Sardis continued as a center for production of textiles, which came to include gold-woven fabrics; but eventually the gold gave out and the memory of the gold sands of Pactolus is mentioned as a thing of the past in the time of the Roman Emperor Augustus. Much information about life and the constitution of Sardis comes from Greek inscriptions on marble collected by scholars over the past several centuries. Lydian, on the other hand, disappeared as a written language.

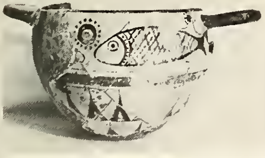
Numerous events in the life of a great city were known from writings of ancient Greek and Roman authors, and yet almost nothing was known of the city of Sardis itself until the beginning of the twentieth century. It cannot be said that Sardis was lost, because the Turkish name Sart remained attached to a village and thus clearly indicated the general location; but violent runoffs, landslides, and earthquakes had thoroughly covered almost everything except some ruins of Roman and Byzantine times. Only the vast mounds of the royal cemetery bore witness to Lydian greatness. These were investigated in 1853 by the German consul in Izmir, who tunneled into the huge mound of Alyattes, the father of Croesus, and first brought to light some Lydian pottery. Not until Howard Crosby Butler of Princeton mounted an expedition in 1910 was anything coherent known about the Lydian culture or Lydian language. Butler concentrated on the huge temple of Artemis, of which two columns were rising out of a landslide that had buried the temple some forty feet deep,



Industrial building of the Hellenistic Age (3rd or 2nd century B.C.) had central row of supports, probably wood on marble blocks, three of which are seen above. Foundations alone remain of structure, which measured 25 by 65 feet.

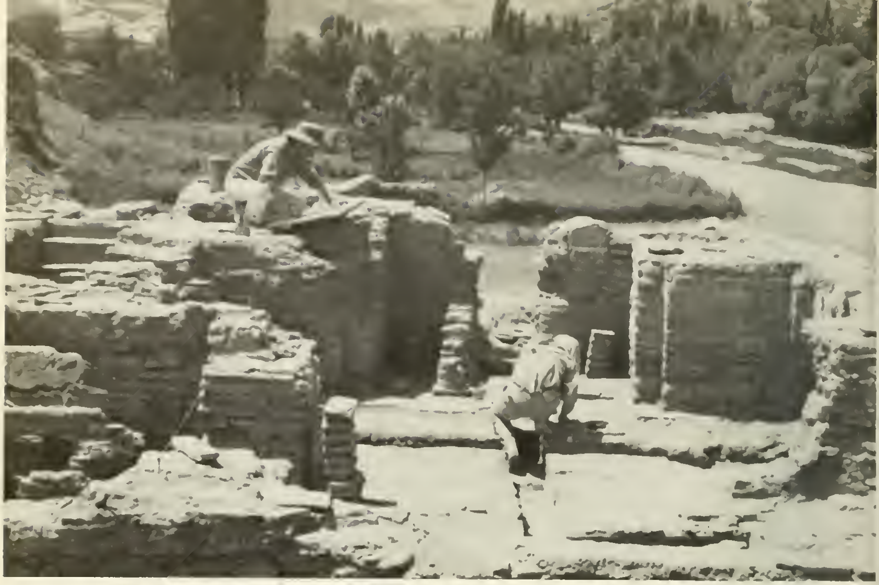
and his workmen opened 1,100 graves, all but 70 of which were empty. Out of the graves came much Lydian and Greek pottery, and a number of inscribed grave slabs were found. More Lydian inscriptions and some sculptures came from the vicinity of the Artemis temple, and the first colorful painted terra-cotta reliefs of the time of Croesus. In 1922 Butler's assistant Theodore Leslie Shear had the good fortune to find a "pot of gold" with thirty-six gold coins of Croesus. What remained unknown was the ancient city itself; even the age and purpose of ruins visible aboveground could not be interpreted with any confidence.

To study the development of Sardis as a human community from the earliest to modern times is the purpose of the joint Harvard-Cornell expedition, which has been working at the site since 1958 under the sponsorship of the American Schools of Oriental Research. The task turns out to be vast and complicated. At the time of its greatest expansion Sardis covered well over five hundred acres. In five summer campaigns the Harvard-Cornell team has dug up a little more than



Seventh-century B.C. cup with a motif of swimming fish might verify a legend of fish-shaped god in Lydian pantheon.

Mysterious Lydian pot sets, *right*, and single one, *above*, contained bones of puppies, perhaps eaten ceremonially.



IN ROMAN BATH, basement of which is above, hot air was circulated under the floors, which were suspended on brick piers, and by terra-cotta pipes in wall.

four. Gradually, vital knowledge is being gained in showing how civilization developed and what material remains were left by the various successive cultures. Two deep probes along the modern east-west highway have established that in the Late Bronze Age, at least in one part of Sardis, people lived in small wattle and daub huts and buried their dead right under the houses. Bits of pottery indicate that the Sardians were in contact with the famous Mycenaean civilization of Bronze Age Greece, but whether that contact was a peaceful or a hostile one we are not as yet able to say.

ALTHOUGH flooded out time and again, people kept coming back to this area close to the ford over the Pactolus torrent. By careful examination of pottery from the deeper strata, we can prove that Lydian culture existed in the Early Iron Age, possibly as early as the eleventh century B.C.

In the time of the Lydian kings (*ca.* 680-550 B.C.) this low-lying ground served as a market and shopping district. Here, and in two digs along the eastern bank of the torrent Pactolus, Lydian buildings have been excavated and recorded for the first time. The small structures in the bazaar area are shops of potters, lampmakers, and perhaps coppersmiths. They are very

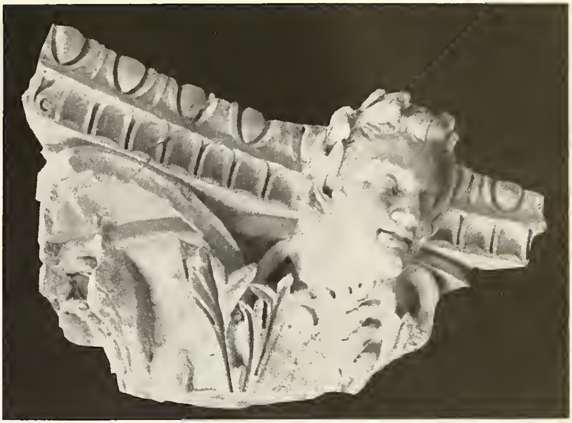
MARBLE PEDESTAL with cross stands in church built prior to Turkish capture. Sardis is one of "seven churches which are in Asia" referred to by St. John.

simply built with mud brick or mud (pisé) walls on foundations of irregular river stones. Remembering the splendor of Croesus, one could wonder at this contrast: but the ancient historian Herodotus noted that despite its riches, the city of Sardis consisted largely of thatch-covered huts.

YET the Lydians could build magnificently in monumental marble masonry. The mounds of the royal cemetery contain regular apartments, usually a corridor, a hall (antechamber), and a chamber built entirely of regular stone blocks beautifully fitted. These chambers are spanned with stone beams that weigh several tons. One of these beams measures 12 by 9 by 3 feet. The engineers of 600 B.C. must have used considerable man or animal power to bring such loads down from the quarries in the mountains and several miles across the plain.

If the archeological finds thus provide a better appreciation of the great differences between the modest daily life of the artisans of Sardis and the fabulous riches of the Lydian kings and nobles, they also confirm that the traffic and trade of the Lydians was widespread. Seals and vessels of faïence and alabaster from Syria, Egypt, and Mesopotamia, and pottery from the Greek mainland ports of Corinth and Athens are eloquent witnesses to the travels of people and goods.

There is reason to believe that when the so-called Seleucid kings, descendants of one of Alexander's generals, Seleucus, established themselves in Sardis about 280 B.C., they may have replanned the city. The method of laying out new towns on a grid plan or replanning old ones was used on a great scale by Alexander during his conquests, and his successors followed suit. From historical writers it is known that the Seleucid kings fortified the lower town of Sardis. In 1960 we discovered a marble tower on a citadel, which proves that there, too, the defenses were brought up to a new strength. Metal-working continued in the bazaar area; a large building with internal supports that may have been a workshed. Unfortunately, a tremendous earthquake in A.D. 17 had so destroyed the Hellenistic-Greek town of Sardis that the Romans buried much of it quite deeply by fallen buildings and earth when they rebuilt the city. Last summer three marble steps of a Greek building were discovered ten feet underneath the level of the principal Roman avenue.



CORINTHIAN COLUMN capital with head of laughing faun came from entrance court to the huge Roman gymnasium. It was built in the second century B.C.

ALTHOUGH the Roman emperors were prompt to help after the great earthquake, probably nearly a century passed before the city was rebuilt completely. It flourished then as never before. It was in the time of Roman peace and in the early centuries of the Eastern Roman (*ca.* A.D. 100-600) so-called Early Byzantine Empire that Sardis covered the largest area and had the largest population, perhaps over one hundred thousand. It certainly reached the highest standard of living in its history. An aqueduct brought from the mountains abundant water, which was distributed through an amazingly elaborate system of terra-cotta pipelines to public fountains, public buildings, and probably to many private houses. Baths with hot-air heating were constructed in various parts of the city. Rich houses with mosaic floors were built in terraces on the hillsides. A marble avenue fifty feet wide, flanked by colonnades, carried the east-west traffic through the town past shops where jewelers plied their trade. The Romans planned on an imperial scale. The gymnasium, an institution that was not only a place for athletics, but also a civic center for social and cultural activities, took up more than seven acres. Its major unit, a hall four hundred feet long, was masonry and cemented rubble, but every wall was clothed with slabs of many-colored marbles. Magnificent architectural and sculptural decoration was applied to most of the interiors and façades.

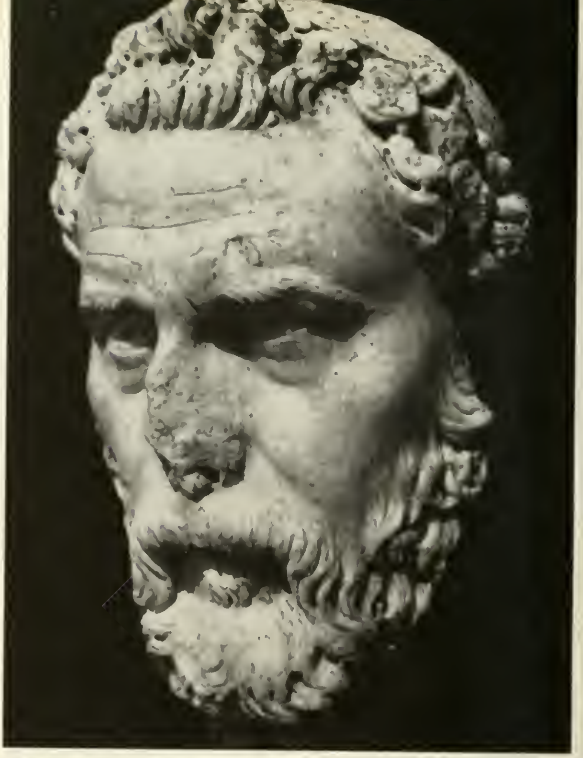
This prosperity was made possible by the great development of overland and overseas trade within the Roman Empire. One of the specialties of Sardis may have been the marble trade. Works of sculpture, especially luxuriously decorated marble caskets, were widely exported. We hear of an armament workshop. The textile industry probably continued if only for local consumption. Otherwise, the traditional productivity of vineyards, orchards, and grain fields must have been a mainstay of the economy. The leading families became Roman citizens and rose to the highest offices of the empire. The wife or daughter of a Roman consul was buried in a mauso-

LYDIAN DICE of baked clay are later than those of India and Mesopotamia.

leum at Sardis. When the gorgeous Marble Court of the gymnasium was inaugurated in A.D. 211, among the benefactors named in the building inscription was a lady who several years before appeared near the head of the "court-list" in Rome.

YET, Sardis also held a very different kind of people, the humble in spirit to whom St. John addressed himself in the Revelation. "Thou hast a few names even in Sardis which have not defiled their garments and they shall walk with me in white. . . ." One of the earliest Christian communities must have grown up in the city; by the second century Sardis already had a famous bishop, Melito. The Jewish community at Sardis, among whom the first Christians were perhaps to be found, was already numerous under Julius Caesar. He and the Emperor Augustus intervened to guarantee freedom of worship. Last summer a monumental synagogue of the third century A.D. was discovered within the gymnasium complex. Much interesting information about the Jewish community has come from fragments of some inscriptions in Hebrew and perhaps a hundred in Greek. Shops, which seem to have belonged to Jewish merchants, have been found next to the temple.

The last great phase of the old Lydian capital came at the time when the Roman Empire divided into east and west (A.D. 393). Although such



ROMAN HEAD of marble, *ca.* A.D. 400, belonged to a statue on a colonnade.

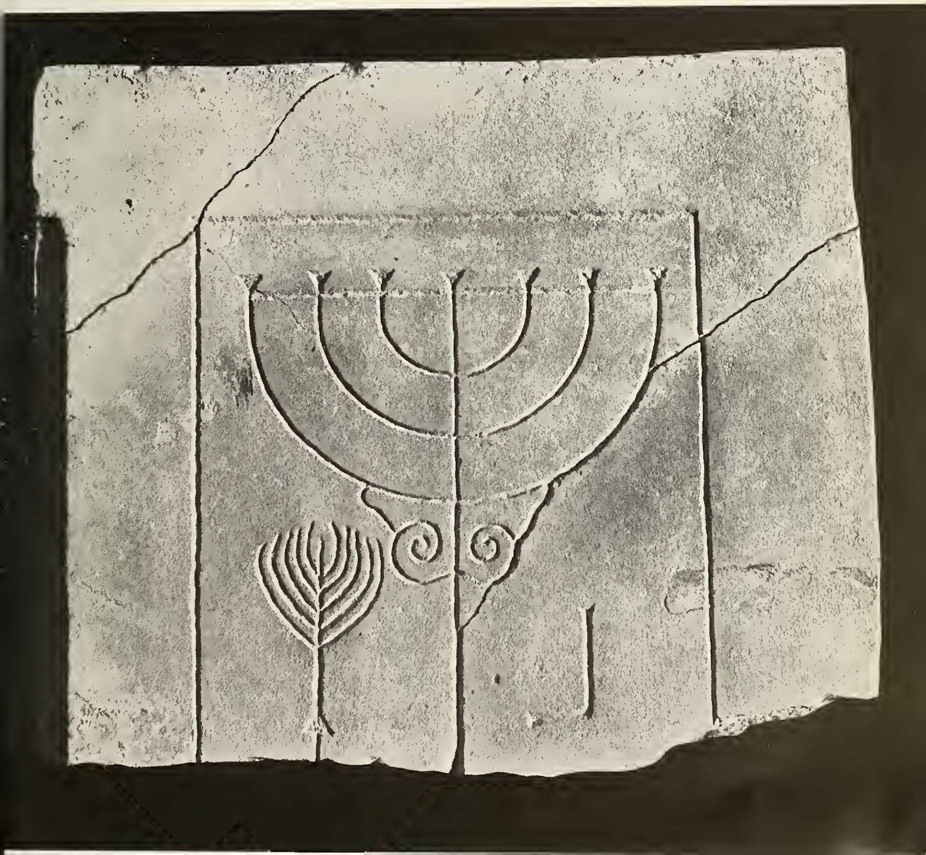
BRONZE BOAR, about four inches long, was probably portion of horse trapping.

pagan institutions as gymnasiums were abandoned. residential and commercial construction still flourished. In fact, the main avenue of the city and the shopping center along this thoroughfare seem to have been either laid out or rebuilt at the time. Rich dwellings with colorful mosaic or marble floors were still being constructed; one of these yielded Christian liturgical implements and may have belonged to a high-placed churchman. Some emergency or anticipated emergency (perhaps an invasion by the German tribes) made the citizens build a new city wall in a great hurry, but the city continued to spread outside it. A highly productive glass industry now joined the other crafts to supply the shops with hundreds of drinking cups and plates and with glass panes for the public buildings.

Then, with one blow, Sardis was nearly wiped out. Almost every building so far excavated shows traces of fire and forcible destruction. The blow was more devastating than the terrible earthquake of A.D. 17; this time nobody tried to rebuild. The most probable guess is that the invading army of the Persian King Khosroe II (A.D. 615-17?) inflicted the disaster although natural catastrophes may have followed. The millennial continuity of Sardis as an urban center is broken; but for several centuries Sardis remained a metropolitan see and at least one of its churches was rebuilt around A.D. 1300. There are traces in various areas of squatters settling in the ruins, of limekilns burning the gorgeous marbles from the mighty Roman buildings. Then the citadel was occupied by the Turks. Our excavations have uncovered a small hoard of silver coins that seem to show they held the citadel against dread Tamerlane when he swept across Turkey in 1405. Little village houses and workshops clustered here and there in the ruins. Around A.D. 1500 Sardis was probably smaller than the modern villages of Sart Mustafa and Sart Mahmut.

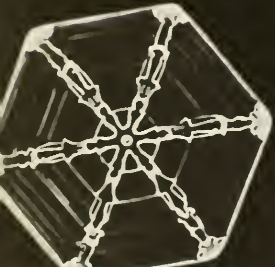
Thus Sardis is significant for two reasons: it illuminates the unique role of the Lydian kingdom in the economic history of mankind and is also an almost classical test case for the rise and fall of the urban pattern of life.

Symbolic candlestick, or Menorah, the palm branch, or Lulab, and the ram's horn, or Shofar, incised on stone slab, helped identify 3rd-century A.D. synagogue discovered in 1962. Many Jews lived in Sardis at time of Julius Caesar.



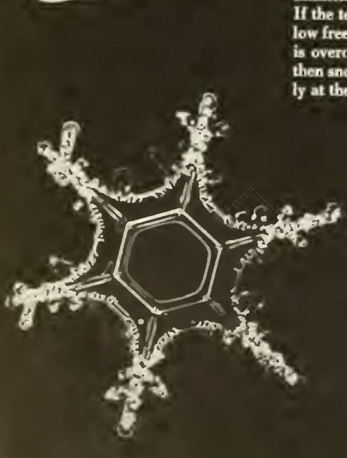
BEAUTY IN SNOW

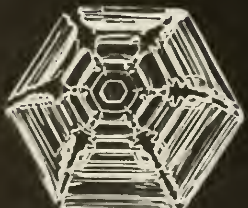
Ice crystals tell of own formation

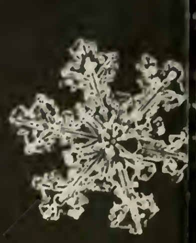


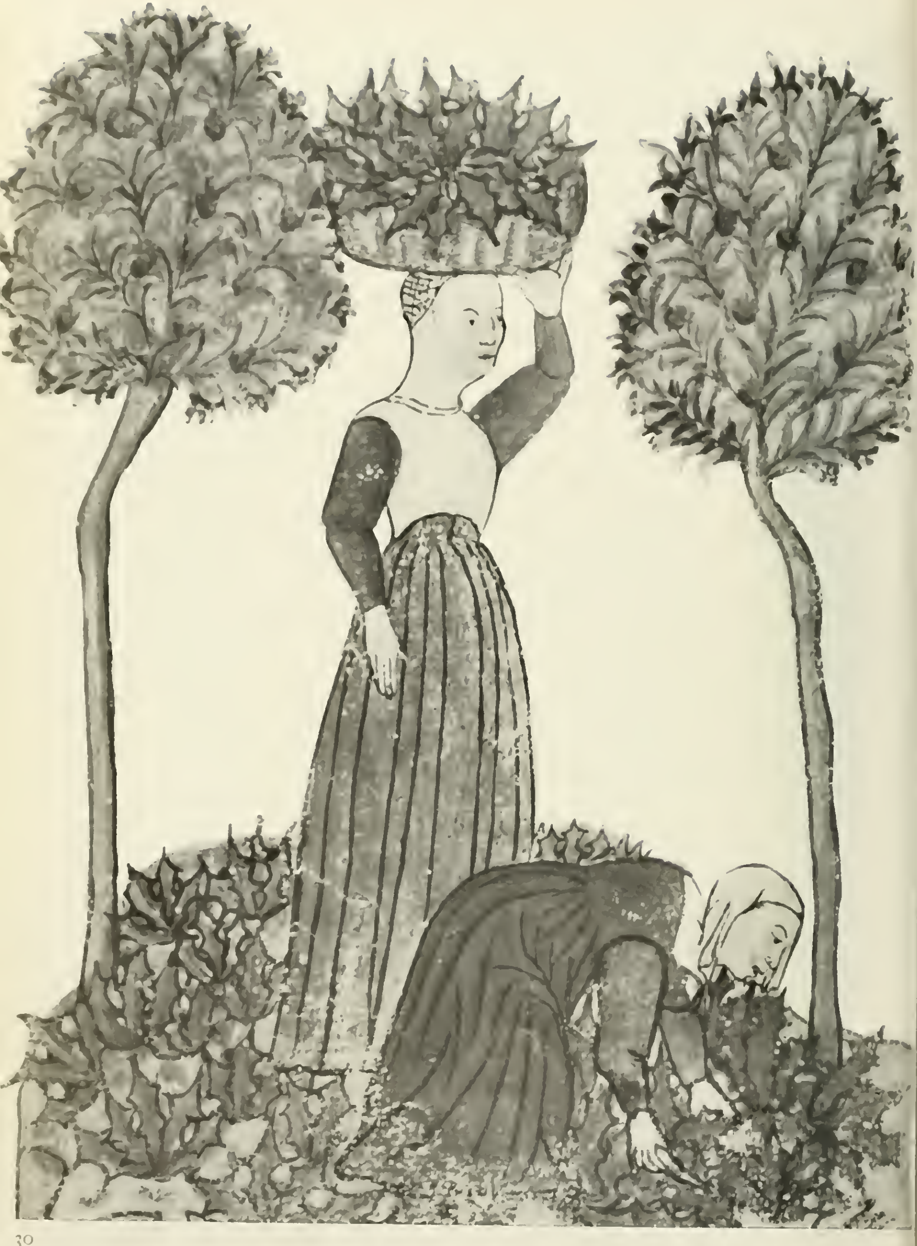
SNOW CRYSTALS form at freezing temperatures through the deposit of a film of water molecules around a nucleus such as a dust, soot, or ice particle. Further cooling freezes the film, then more water molecules from the atmosphere condense on it. The diameters of natural snowflakes range from infinitesimally small to about ⅓ inch. If the temperature suddenly drops below freezing or the region of formation is overcrowded with water molecules, then snow crystal growth occurs mainly at the corners, and hexagonal stars, or dendrites, form. Most of the crystals shown here, in photomicrographs courtesy of Carl Zeiss, Inc., New York, are dendritic specimens.

In falling to earth, snowflakes generally pass through various developmental states that are determined by such variables as temperature and water vapor pressure. Consequently, there is an almost endless diversity of snowflake patterns. However, few crystals reach the earth undamaged, since even minor atmospheric turbulence makes the fragile structures collide.









"ABSINTHE is warm in the first and dry in the second degree; when eaten it brings down choleric humors; the stem prohibits drunkenness; when mixed with wine and taken through the nostrils it will calm down anger, and it will purge you." Thus begins, enchantingly, somewhat unscientifically, but not entirely unsuitably, a manuscript of the *Tacuinum Sanitatis,* now the property of the Spencer Collection of the New York Public Library. It was written in a north Italian dialect and illustrated during the latter part of the fifteenth century.

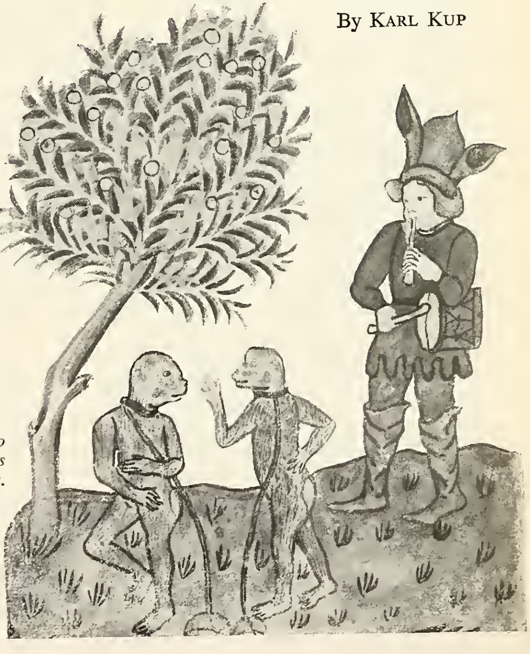
Tacuinum Sanitatis means "tables of health," and is a translation, adaptation, and latinization of an Arabic title. Its compiler was a Christian physician living in Baghdad in the second half of the eleventh century, whose full name was: Abu-l-Hasan al-Mukhtar ibn al-Hasan ibn Abdun ibn Sa'dun ibn Butlan. *Taqwim alsihha* he had named his compilation of flowers, plants, and simples, their properties and healing qualities. *Taqwim* means "straightening," "rectification," or, perhaps most meaningful here, "tabulation." Ibn Butlan's text of synoptic tables of dietetics, hygiene, and domestic medicine is a far cry from the medieval lore of herbs and plants, potions and superstitions, and the strange behavior of man. It is also removed from its classical Greek and Byzantine ancestry. In fact, Ibn Butlan's *Tacuinum Sanitatis* is a milestone in the history and development of man's knowledge.

In the earliest civilizations, animal representation almost invariably preceded plant drawing, and not until plants had become cultivated do we find them drawn on wall and artifact. The prehistoric caves of Spain and France abound with proud and prancing animals—the god-

A Medieval Codex Of Italy

By KARL KUP

Plants, simples, food, and diet are outlined in Tacuinum Sanitatis



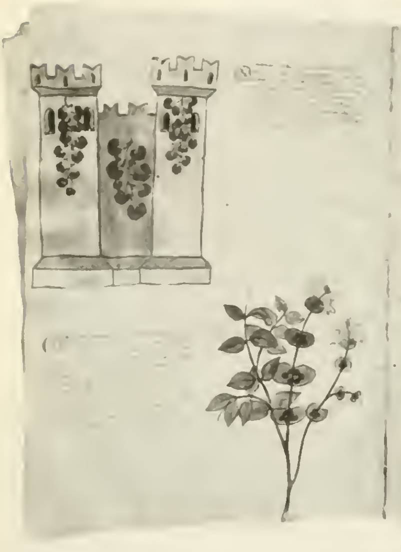
Monkeys, held by weights, dance to music of flute and drum. Jester is wearing typical medieval headgear.

Women pick spinach and transport it in baskets on their heads, just as it is done today in northern Italy.

animal with supernatural power; the sacrificial animal, awe-inspiring and fabulous, surrounds the surface of Shang Dynasty bronzes. Not until the time of Egypt's Thutmose III of the fifteenth century B.C. are we shown realistic plants.

The Pharaoh, having conquered Syria and Palestine, had brought back with him specimens of unknown fruits and herbs. To immortalize his conquest and, perhaps, to teach his people the produce of desirable lands, he had the plants cut into limestone relief on a small temple in Karnak, known to this day as "Pharaoh's Garden." And he had added in writing: "here are all the plants that grow, all the goodly flowers that are in the Divine Land, as I live, all these plants exist in very truth."

How different the classical world! Little attempt seems to have been made to render factual representations of the plant, although there were stylizations of the lotus and of field flowers on Cretan and Greek pottery. Aristotle, Plato's pupil, occupied himself with the science in the broadest sense, philosophically, aesthetically, morally. His influence, especially during Europe's Middle Ages, was profound. He left his library to Theophrastus, his pupil and successor as the head of the school of the Peripatetics. Theophrastus' lectures on the nature of plants were taken down by a contemporary scholar, and copies of this *Enquiry into Plants* are recorded to have existed. They were chiefly concerned with the flora of Mediterranean Greece. What was written down "on other lands," scholars tell us, was taken from Alexander the Great, himself a pupil of Aristotle, and one who had taken scientific and scholarly observers with him to the East.



Ivy-leaved toadflax and honeysuckle adorn page of herbal, which is highly unorthodox in its design.

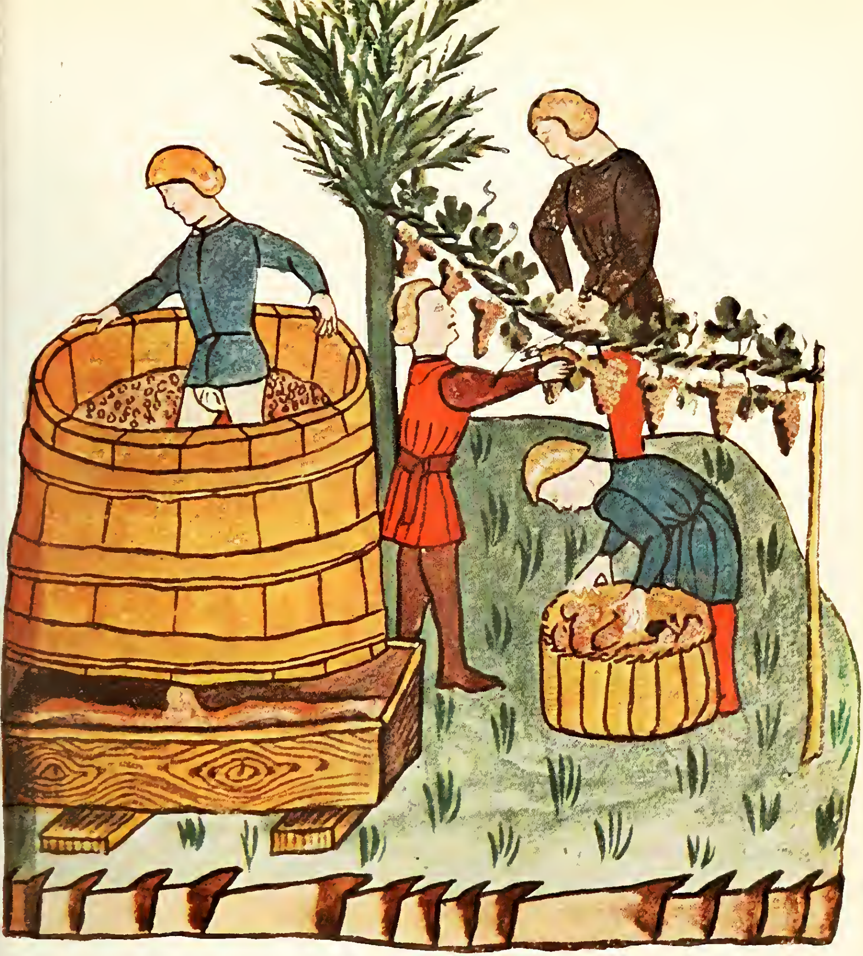
It seems unlikely that Theophrastus' books were not illustrated; yet we have no proof except for a comment by Pliny the Elder, who said later that he condemned all colorfully illustrated herbals as deceitful. One of the artists mentioned by Pliny is one Krataeus, physician and court painter for Mithridates III (56-55 B.C.). His drawings have perished, but their design was taken over into the manuscript herbals of the early Christian Era.

In the first century of this era, a humble Greek scholar named Pedanius Dioscorides, a native of Anazarba in Cilicia, was a surgeon with the Roman army, and in his extensive travels collected information on plant and herb remedies. Quoting Greek and Egyptian sources, he compiled a materia medica, the Western world's first pharmacopoeia. A splendidly illuminated manuscript of this treatise, with hundreds of drawings of plants and simples, copied in the sixth century, is now in the Vienna Nationalbibliothek, and is known as the *Codex Vindobonensis.* In direct line, yet watered down, as is often the case, it is the ancestor, textually and illustratively, of the *Tacuinum Sanitatis.*

This manuscript is a large book with illustrations and captions. One illustration is set into the upper right and another in the lower left corner of each page. The descriptive matter ranges from four to about twenty lines for each subject, according to the significance and complexity of the healing and medical properties and qualifications it contains—or, perhaps, according to the compiler's or author's knowledge and his access to outside sources. The text is placed horizontally next to its pertinent picture, in a refreshingly simple checkerboard pattern.

There are 408 colored drawings of plants, trees, fruit, flowers, animals, meats, poultry, eggs, fish, and cheese. Their texts speak of their *complexio,* or nature, such as *caldo, fredo, humido,* and *secco*—warm, cold, moist, and dry—and also of their *juvamentum,* or usefulness, their *nocumentum,* or danger, and of their *remedio nocumenti,* or means of preventing danger.

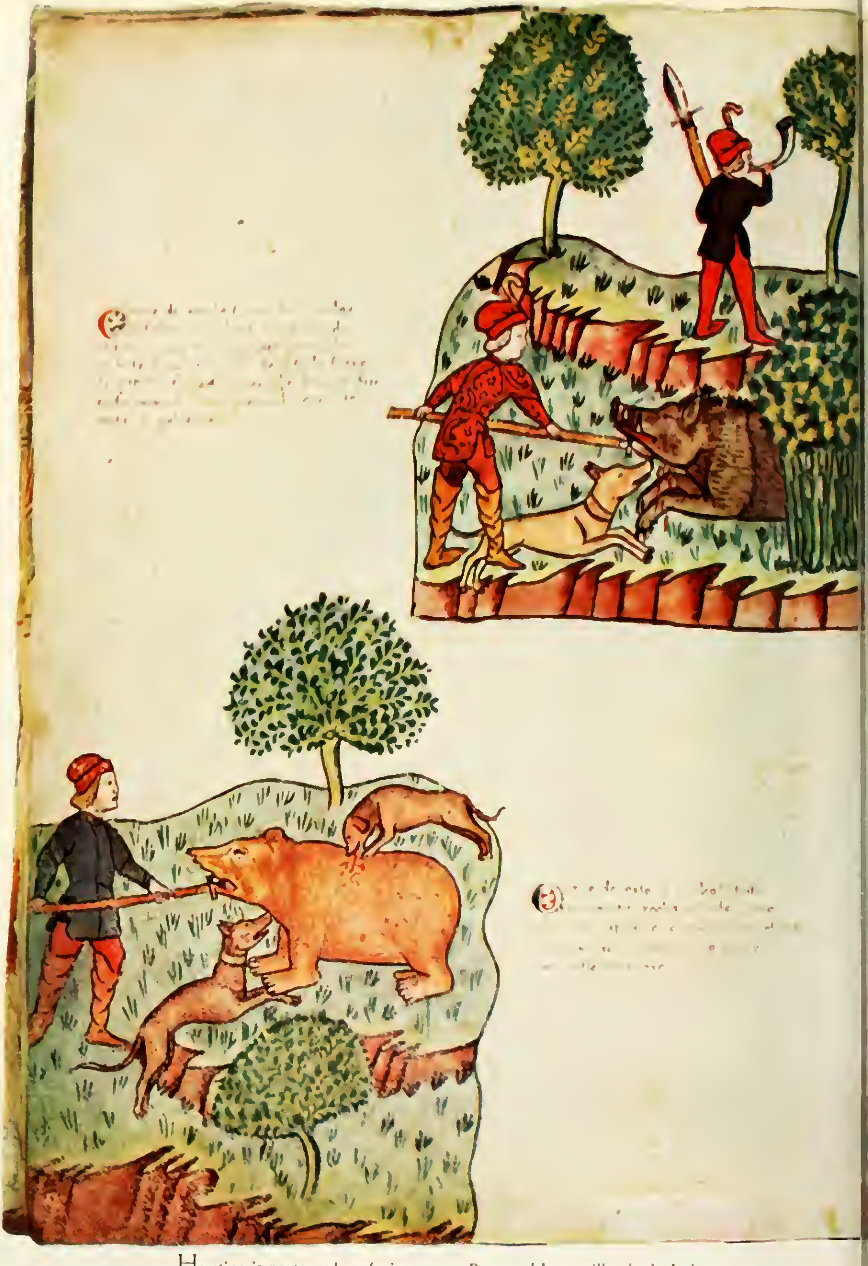
Listed in alphabetical order, the more than two hundred plants and simples of the first part of the *Tacuinum Sanitatis,* in the order of their arrangement and with but few exceptions, are



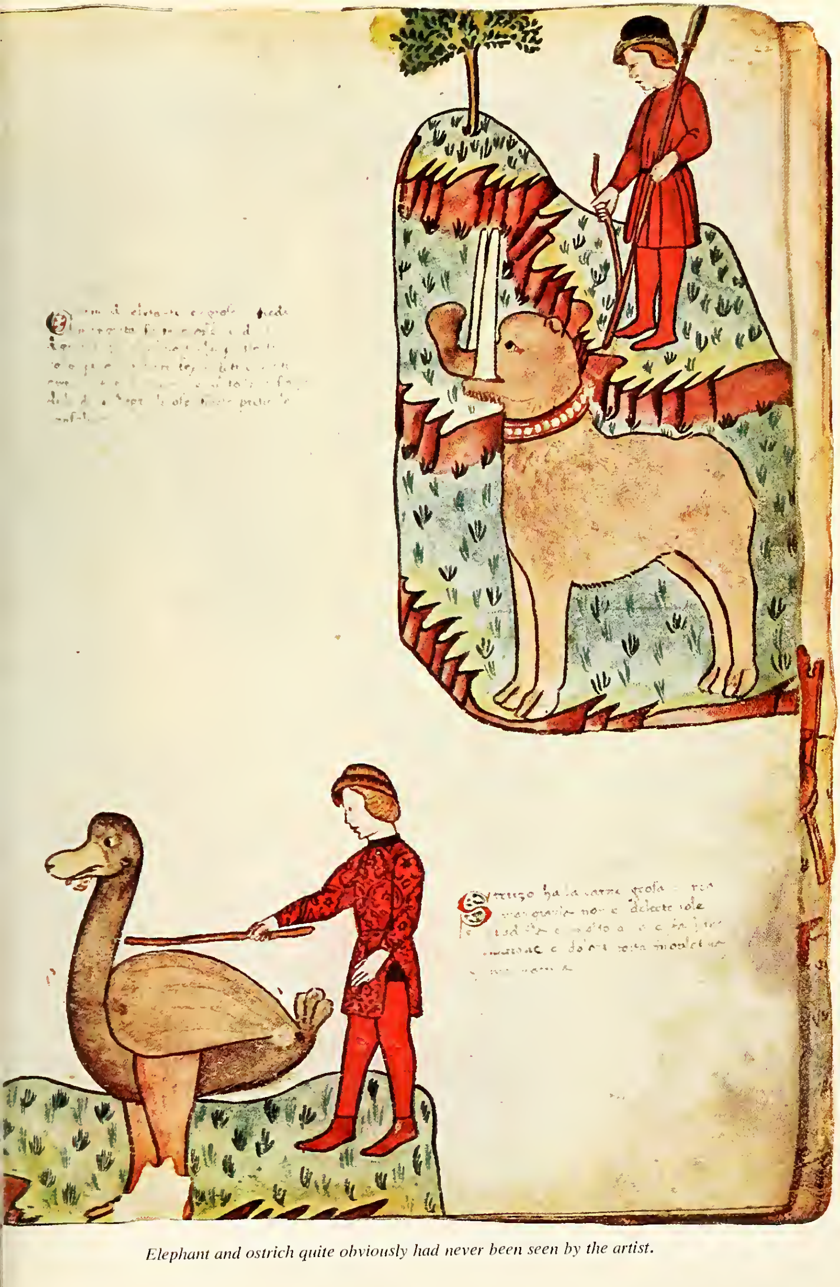
Grapevine grows between trees, in age-old fashion, and fruit is picked, sorted, and trodden for wine.

based on earlier prototypes of herbal and flower books. From *absintio*, or absinthe, to *volubile*, or bindweed, we are taught how to use the best of each. Does not *volubile* cure intestinal trouble or, in the language of our manuscript, "cocto con oleo de amandanole cura lo dolore de li intestine"? But not all of the plants and herbs and their "properties" derive from classical or scientifically sober sources. Much medieval superstition has crept in. *Cauda porcina* has a small black pig for its roots, *dragontea* a small dragon, and the roots of *mandragora*, of course, are shown in the shape of a little bearded man!

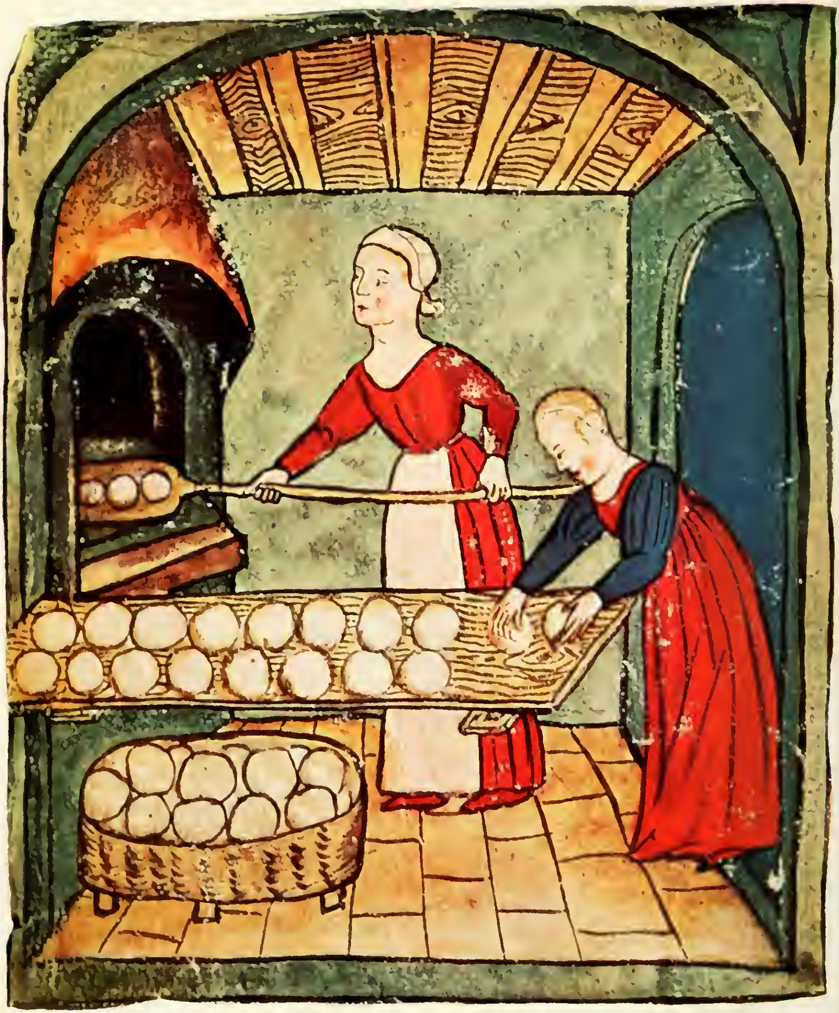
Perhaps the most interesting part of the manuscript to us today is a wealth of small and ingeniously rendered genre scenes of daily life such as a camera might have caught in northern Italy in the fifteenth century. It is the time of the Renaissance in the larger and cultural centers of the country, to be sure. Magnificently illuminated manuscripts that project the new learning for the lord of the manor, for the educated merchant, for the princes of the church,



Hunting is portrayed on facing pages. Bear and boar still exist in Italy.



Elephant and ostrich quite obviously had never been seen by the artist.



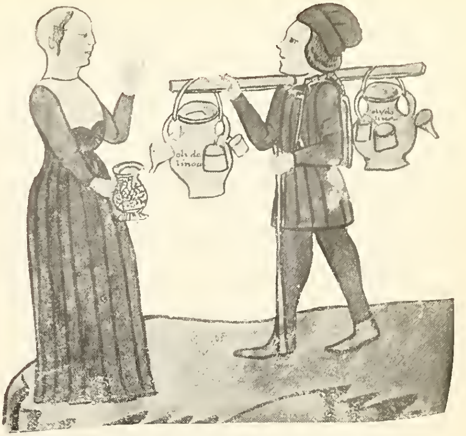
White bread is placed in wall oven on long-handled paddle in bakery much like contemporary versions.

are being turned out in great numbers. But the manuscript, although written or copied at about the same time, deals with subject matter close to the average person. While it is true that its derivation was from classical sources and classical learning, it became interwoven with medieval lore, practice, habit, and tradition, because it had to become and remain close to people who upheld superstition, habit, and tradition. They did not wish to be taught "better."

These genre scenes are crudely drawn yet direct and realistic. They are the best possible proof of the lives and occupations of the Italian *cittadino* and peasant of the fifteenth century and of life in a small northern community. They show us how people lived, and people did not live badly. The farmers are well dressed and go happily about their task of planting and harvesting; the shopkeepers have an air of dignity only to be matched by the aloofness and security of the customer. The furnishings are solid and simple. Merchandise is abundant. Here is the apothecary in his laboratory or office, dispensing pill and potion. The merchant of grain and flour stands behind the counter of his arcaded wooden stall. The "outgoing order" cook is so busy with her chickens and soups that her head is bent over her task and her back is turned toward the spectator. The harvesters seem to be singing as Italians do when they gather vegetables or grain, olives or fruit. The scenes of the preparation of the many foodstuffs, such as bread, macaroni, wine, meat pies, tripe, and salted fish are a treasure-trove for the student of economics and sociology.

THERE is also subject matter for the psychologist, and these scenes may have originated with Ibn Butlan, who, let us not forget, was a physician, not a botanist. They are descriptions, prescriptions, and illustrations of the physical effects of sleep and waking, "uno che non po dormire," showing a man lying in bed, staring up at the ceiling, while two youths play viols to soothe him to sleep. There are renderings of *ira,* or wrath; of shame and sheer happiness. In these the illustrator was given free rein to draw his subject as realistically as his conscience permitted or as esoterically as his imagination led him. There are also illustrations of wind and rain, of spring and autumn, even of ice and snow, so rarely rendered in Italian art; and these scenes are drawn hauntingly, mysteriously, almost surrealistically. Then we are confronted with scenes of the hunt: hunting the boar, the bear, the elephant, the ostrich, to mention the less familiar game of Italian soil first! These are followed by the stag, the deer, the badger, the hare, and the rabbit. Porcupine and beaver come next, the latter stalked in the river's bed. There are quail, there are duck and other waterfowl, and many other migrating birds, such as the ortolan and stork. The manuscript ends with a few full-page illustrations, based on other sources, of medicinal baths and spas: people swim and bathe, are massaged, wine and dine, play games, and are bored.

A last and final chapter, which possibly was taken from Emperor Frederick II's treatise on falconry, *De Arte Venandi cum Avibus,* so popular throughout the Middle Ages, explains this chivalrous pastime of the upper class to a less exalted reader. The text moralizes on the pursuit of such activity. It admonishes the reader that time for play and frivolity is reserved only for the few and it specifies that falconry is a sport practiced only by the wealthy and great.



Merchant sells both linseed oil and olive oil, and his customer carries her purchase in a faïence jug.

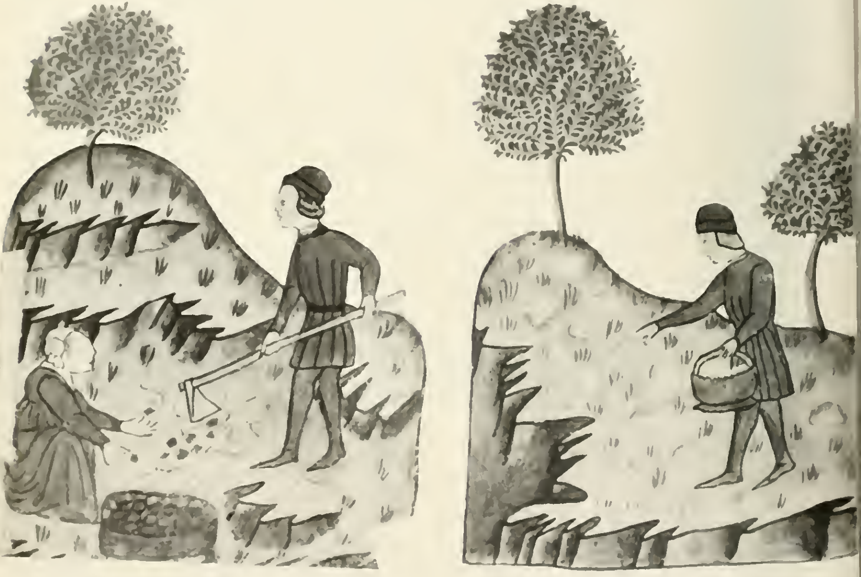
The drawings are powerful for a manuscript of this nature. At first sight, they look like the woodcuts of the incunabulum period of printing. These were colored by hand, and the sharp outline served as guide for the color to be applied, often in imitation—although not fraudulently—of illuminated manuscripts. On second look it can be seen that, faintly and delicately, an artist or designer drew a preparatory and guiding sketch for the finisher, who, in turn, firmly and boldly covered the outline of the composition. He then applied the solid colors where solids were needed, added shading and pattern, offset many solid parts with lighter strokes of the brush and in lighter color, and thus rendered a "miniature" of almost three-dimensional perspective and quality. In some cases, we can still find traces of manuscript instructions to the finisher. Below a lightly tinted border of a butcher's shop, we find *vitello* (veal) written in an infinitesimal hand. The whole is set in the interior of the butcher's shop with parts of earlier victims still hanging from the rafters. *Cervello,* written faintly beneath the now-colored portion of the foreground of another miniature, and legible only with a magnifying glass, gives instructions or brings to the imagination of the draftsman the scene in the arcade-stall where an owner examines a tub of brains. He gesticulates toward an apprentice who carries another filled tub.

By far the best portion, artistically, is the herbal and plant part of the *Tacuinum Sanitatis.*

Traditionally drawing on Dioscorides, Ibn Butlan's medieval illustrators added observations of their own and, in contrast to earlier periods and in keeping with the new learning of the time, actually drew from nature itself. That is why some of the botanical illustrations appear so fresh, spontaneous, unstudied, and unarranged. In outline and in two-dimensional drawings, these plant illustrations are airy and free; their colors are somber, with greens of many shades and intensities predominating. Yellow or red fruits add gaiety to a page otherwise simple and dignified.

This is not so with the second part of the manuscript, which contains the scenes from daily life. Here our eye is amused by incongruities in representation and rendering, and we are enchanted by their abandon. Again, the outlines are firmly drawn, the colors solid, with deep red and deep green predominating. Red is for the many and simple costumes worn by the peasantry of the time. Women are shown in low-cut, heavily pleated dresses; young men wear short surcoats, leotards, and pointed shoes; the more sedate and advanced in position are seen in pleated and girded knee-length coats and round flat hats. The hair styles show nets and kerchiefs for the women and girls and deep, hanging locks for the men, both of which are familiar from much of the portrait painting of the time. But in addition there are many characteristics specifically of northern Italy and of the period: the basket of fruit carried on the head, the crocks of milk at each end of a stick carried across the shoulders, the wattle basket, the large Italian caldron before the open fire with chimney above, the faïence beakers of wine, the large grapes cultivated and grown on trellis or espalier hung between trees.

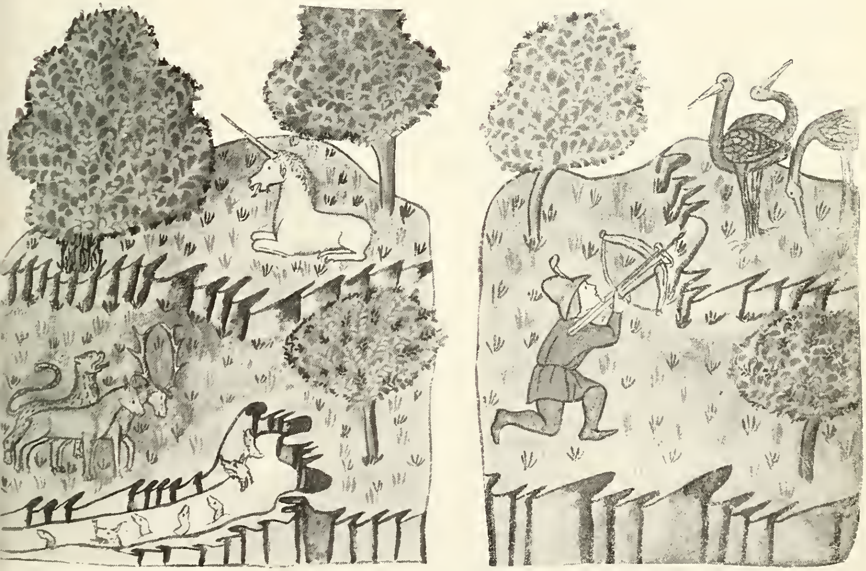
Formaggio fresco is a striking "still" of the making of cheese. In his shop, the owner is working over the last wheel of a *provolone;* a dog laps up the remnants that have fallen from the table; cheese is cooked over an open fire. This little miniature is set within an architectural frame like a small stage. It is a perfect interpretation of the character of both the man and his profession. In another, *spinachi,* good for *la digestione,* is gathered in the garden and carried into the house. *Pane azimo,* unleavened bread, is cut and eaten—picnic style on a garden bench and in the shade of two stately trees—by two gentlemen. But above all, *uve,* or grapes, are cut from a trellis, heaped in a tub, and



Food-gathering activities range from the mundane to the fanciful. In first picture a hoe is used to dig for truffles; in the second, mushrooms are gathered in a mountain meadow. The influence of mythology trodden by bare feet. Soberly and medicinally, the northern Venetian dialectal text instructs the reader that "le migliore sono le grande a cura li tossicchi"—the larger grapes are good for whooping cough!

WHERE do this text and illustrations come from? What are their ancestors, their prototype, their connection with the world? It has been said that Ibn Butlan's eleventh-century text had been written and, perhaps, illustrated during the author's time. It must have existed in Arabic or Eastern manuscript versions, because we know that a southern French physician, whose name has not come down to us, made a translation into Latin from an Arabic text sometime during the middle of the twelfth century. Can we assume that the crusaders had brought this version with them? Can we assume that an Arabic text found its way into the French physician's hand through the Spanish Moors? No matter how it came to the Western world, the Western world was ready for it. It gave the reader more than did the already existing *florilegia, herbaria,* and *horticultura,* because it had added textually something extremely important —the medicinal, dietetic, and therapeutic properties of plants. Also added were Ibn Butlan's descriptions and interpretations of man's reaction to such phenomena as sleep and awakening, love and hatred, wind and rain, work and play. Here, the searching medieval or early Renaissance mind could add matter to its heart's content and, surely, must have done so, because we have proof that the medieval *Tacuinum* merged in time with a much abbreviated version of the alphabetically arranged herbal compilation.

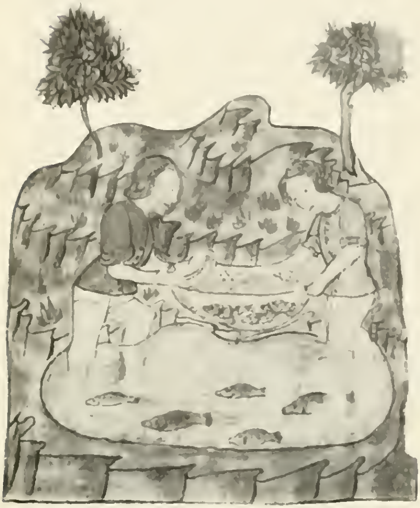
How much of the basic text of the first translation was rewritten, added to, or padded, I do not know. However, I do know that it appears, and splendidly, for the first time in a number of illustrated manuscripts that seem to have been made to order in a scriptorium near Verona, in the later half of the fourteenth century. Three of these illustrated manuscripts of the *Tacuinum Sanitatis* have become famous in the literature on dietetic, medical, herbal, and art history. Each has been examined and described by scholars; one has been facsimiled, the others appear time and again in literature. They are the *tacuina* of Rome's Biblioteca Casanatense, of Paris' Bibliothèque Nationale, and of Vienna's Nationalbibliothek. The latter is better known because it has been the subject of a special monograph. It is known as the *Hausbuch* of the



is clearly visible in the portrayal of a unicorn, a deer, and a panther, and odd creatures, two of them dragon-like, in the water. In the last panel, a hunter kneels as he takes aim at cranes with his crossbow.

Cerruti, a Veronese family, for whom it was written and illustrated about the year 1385.

The immediate ancestor of the illustration cycle of the *Tacuinum* under consideration can and must be found in the Vienna *Hausbuch*. In choice of text and illustration it is almost a copy. But its text was translated from the formal Latin to a most informal northern Italian dialect, either from Venezia Tridentina or from Lombardy. Its illustrations, drawn not by an artist but by a worthy craftsman, have become abbreviated, simplified, contracted versions of the greater and almost elegant miniatures of its model. There are directness, crudeness, and simplicity about them that put our manuscript into another category of medieval bookmaking —that of the book for the people, the book to be used, read, and reread. Vellum had given way to paper; elegant Latin to popular dialect; splendidly executed *gouaches* to pen-and-ink drawings. Courtly ladies and proud knights became citizens and townsfolk; richly dressed shopkeepers and their groomed apprentices became portrait-like figures of the village or the small town; Gothicized architectural settings and frames for individual scenes became wooden openings or, when the scene was laid in the country, roughly hewn, rocky foregrounds.



In a highly stylized scene, fishermen seine their catch from turbulent waters of a hillside stream.

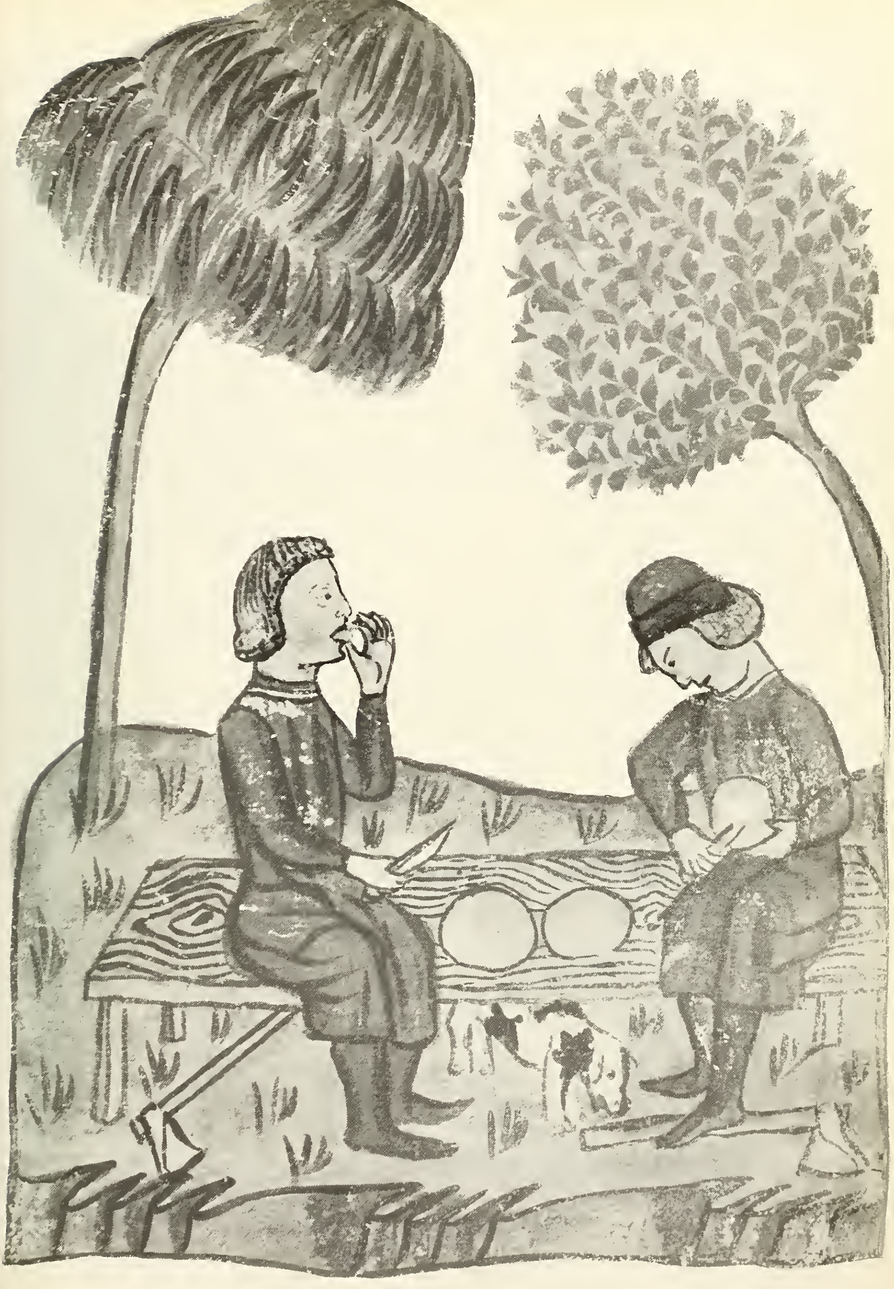
Is it possible that our manuscript was copied for a special client, a patron? And if so, who was he that he would want or could afford only a facsimile on paper with pen-and-ink drawings so different in quality and style that only subject matter relates copy to model? This popularization must have had a reason.

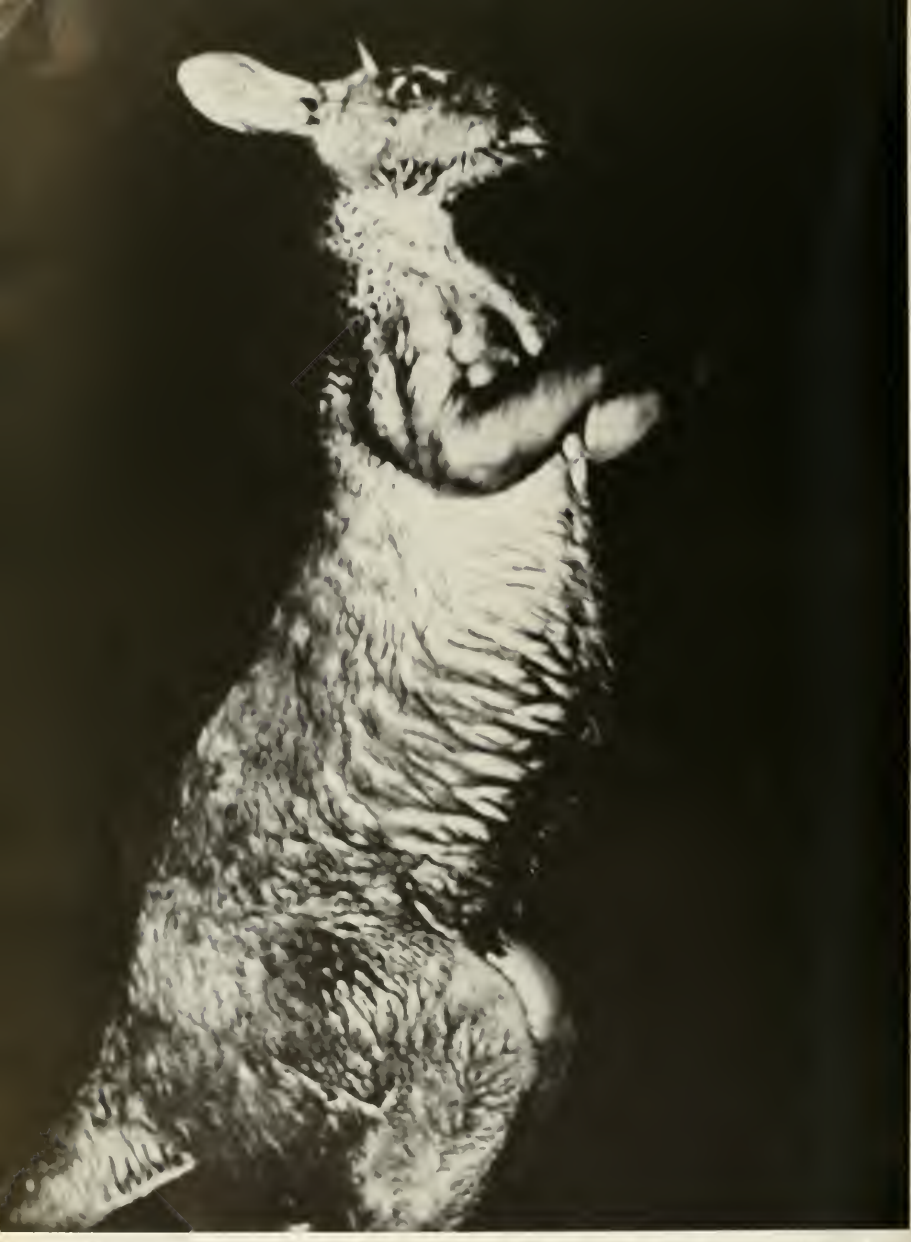
In Vienna's library there is another abbreviated, rough version like our own *Tacuinum*, this one ascribed to one Giovanni Cadamosto, about whom very little is known other than that he was a "gentleman from Venice." It has an owner's entry: *Bartolommeo de' Bonsignore et amicorum—1472*. Bartolommeo lived in Arculi near Verona, but his home was Lodi, close to the German border. Is Cadamosto the translator into the vernacular, the dialect? He has given his *Tacuinum* a rather popular title: *Trattato circa le nature de lherbe, de cibi et de veneni, et de loro juvamenti et nocumenti et ad removere li nocumenti soi*. All of it is in the title: the herbs and plants and potions, their usefulness, their danger, and the healing qualities they contain. It reads like a concise table of contents, like an invitation to dietetics, which the word *tacuinum* could not have conveyed to the contemporary man in the street.

WE might assume that our *Tacuinum* was drawn in simplified outline manner in preparation for a printed edition with woodcuts. We do not know, because no such printed version exists. In fact, Ibn Butlan's *Tacuinum Sanitatis* in dignified Latin does not appear in print until the year 1531, when the Augsburg publisher Johannes Schott issued an edition with woodcut borders designed by Hans Weiditz, without any connection whatsoever in subject matter or style with any of the previous illustrated manuscript versions. Is it more reasonable to assume that there was such demand for a book on dietetics that people ordered copies and that the Verona workshop made them according to a patron's ability to pay: a splendid copy for the Count of Württemberg, a simple copy for Signor Bartolommeo de' Bonsignore?

Dioscorides—Ibn Butlan—Cadamosto! Text and illustration have come a long way. What lies before us is part and parcel of our heritage, whether we are interested in science, sociology, psychology, the daily life of people, art, or book production problems at a time when that industry turned from hand to machine, and when man's mind increased a thousand fold and man stood between two worlds as he does today.

Workers stop for their midday meal. Here, as in other scenes, the grain of the wood is emphasized.





MALE EURO, "hill kangaroo" of Australia's arid northwest, attains weight to 100 pounds. Euros have powerful arms for fighting. While their fortunes wax, the big sheep stations dwindle. At right is a scientist taking night euro census.

Kangaroo Cave Life

Cool daytime havens often obviate the euro's need for water

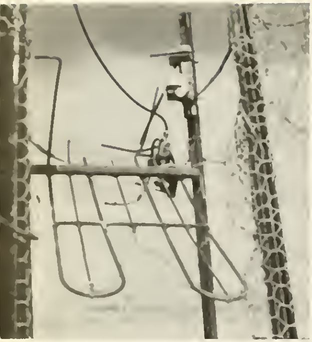
By E. H. M. Ealey

To the modern sheep rancher or government scientific team in Australia, ecology is a workaday concept that must be brought to bear upon problems of an arid land where the balance of nature, and hence the productivity of much of the country, has been too easily upset time and again over the years. And in the experience of Australia's sheepmen, the flocks and the conditions in which they thrive have often seemed to be inversely linked to kangaroos. In the Pilbara district of northwestern Australia, for example, sheep numbers have dwindled by more than half over the past quarter-century, and more than a dozen immense sheep stations or ranches, totaling about eight million acres of land, have had to be abandoned. In contrast, the so-called hill kangaroos, *Macropus robustus*, or euros, have never been more plentiful.

From the beginning, the sheep farmers blamed the euros, which eat grasses similar to or the same as those eaten by sheep, for the degeneration of the pastures; to learn more, the Agricultural Department of the Western Australian Government purchased two adjoining properties, Abydos and Woodstock, to conduct studies of sheep pastures. To handle the problem of the euros, the government called in the Wild Life Survey Section of the C.S.I.R.O. (Commonwealth Scientific and Industrial Research Organization). I was among this group of scientists. In 1955, we set up our headquarters in the deserted homestead of Woodstock station, a ranch that had once known prosperity. We lived and worked among the euros for nearly five years, and it is on this experience that my paper about the euro and the problematic relationship between kangaroo and sheep populations is based.

Sheep and euro populations were competing for the same grasses; we knew that sheep had the potential for producing larger numbers of young than did the euro, yet we saw immediately that in contrast to the performance of the euro the sheep was a comparatively unsuccessful breeder. Even though the sheep gave birth to twins more frequently and reached sexual maturity earlier than the euro, it was nevertheless losing the competitive struggle for the grasslands, despite the aid it received from man. We set out to discover why, and in the course of the investigations in the field, we found we also had to have at our disposal knowledge of the more recent history of this arid grassland, and of fluctuations in both the sheep and euro populations there, together with proximate causes. I would like to summarize this material before setting forth the details of our procedures and findings.

There is a great deal of confusion, even among Australians, as to how many sorts of kangaroos there are. Various color phases and local names help to complicate the situation. The hill kangaroo is one of the three large species (and probably several subspecies) of kangaroos; the other two are the red, *Macropus rufus*, and the great gray, *Macropus canguru*. Aborigines once called hill kangaroos euros or biggadas. Europeans now use both of these names and, in the eastern states of Australia, the word wallaroo.



WORKERS rigged a gate-tripped dye jet device to mark euros coming for water.

Some euros are pale gray in color and others are a beautiful dark red or even black. The colors vary from one population to another, but the males are usually darker than the females in any one locality. *M. robustus* is found sparsely distributed over most of Australia, but in actual fact it is generally restricted to hilly country within this broad range. Males may weigh as much as one hundred pounds, but females never exceed forty-five pounds.

Incidentally, it is interesting to note that males of all the species are larger than females and can be aggressive and dangerous when wounded or trapped. When the red and the gray kangaroos are fighting among themselves, they will balance on their bent tails and kick each other viciously in the abdomen, sometimes inflicting severe cuts with the claws of their hind legs. Men have occasionally been disemboweled by a wounded red or gray kangaroo. Euros, however, do not fight in this way, but bite savagely while gripping each other (or an unfortunate biologist) with their powerful forearms.

WHILE most indigenous Australian mammals have been reduced in number or exterminated since the coming of the European settlers, the northwest euro is one of the few animals whose lot has been improved. For this reason especially, the history of the settlement of northwest Australia was of interest to our study.

The era of the big sheep ranch began in this land during the last half of the nineteenth century. After a colony had been established at Perth in southwestern Australia, explorers began probing the northwest. They found, north of the Hamersley Range, an ancient land called the Pilbara, characterized by low, rugged hills composed of sediments more than six hundred million years old. Great granite magma that erupted through these sediments have weathered and eroded, leaving plains of granite rubble dotted with heaps of boulders or skeletal hills honeycombed with caves and transected by wall-like dolerite dikes. The "soil" is so leached out that it is deficient in all the nutrients that familiar vegetation normally requires. Only the well-adapted plants can exist there, as they must also tolerate extremes in temperature and desiccation.

I should add that summer shade temperatures in the northwest may exceed 120° F., and that only nine to twelve inches of rain fall erratically each year. This occurs principally in summer and is generally the result of cyclones sweeping in from the sea. Stunted acacia trees are scattered across the landscape, and the ground is covered with a spiky grass locally called "spinifex," of the genius *Triodia*. There are several species, but only two proved to be palatable to the settlers' stock and even these were not nutritious. Sheep could subsist on such a diet, but were able to breed successfully only on pastures where grasses and other plants with a higher protein content grew among the spinifex.

Among the early Australian explorers were the Gregory brothers, who, in 1861, undaunted by the inhospitable country, settled with their sheep in the De Grey River area, and were followed within a short period by groups of settlers. At first, sheep were herded around natural water holes. There were enough high-protein plants to enable these early grazers to breed, and the flocks increased rapidly. Eventually water was pumped from underground supplies and large areas ranging from 200,000 to 1,000,000 acres were leased and opened up for grazing. Sheep populations continued to rise. The rate of actual increase slowed after about 1910, when significant numbers of wethers began to be exported to Perth and Singapore.

Most of the virgin country was fenced by 1920. Between 1925 and 1935, sheep numbers were allowed to rise more sharply as a device to augment the total wool clip and thus offset low wool prices; however, this only helped to keep prices down. During this period there were approximately 600,000 sheep in the district. But 1935-36 saw quite spectacular decreases following a serious drought—the sheep population fell precipitously to about 300,000. Although recovery came after the terrible 1924 drought—it was followed by adequate rain and rapid rises in sheep numbers — the drought of the mid-thirties left a lasting aftermath. Because of a change in pasture composition, there were not enough high-protein plant species left to enable sheep to produce and rear the lambs necessary to offset natural mortality. Land that once bore high-protein plants was invaded by unpalatable species. There were three principal causes of this degeneration: the practice of burning old, rank spinifex while rounding up sheep for shearing was effected during the period when nutritious plants were carrying seed; sheep had been run in the same paddocks for many years; heavy overstocking between 1925 and 1935 had inevitably taken its toll.

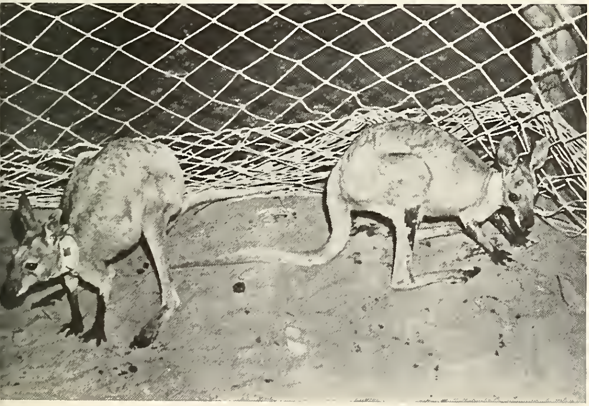
YET as the sheep were facing nutrition problems, euro density was increasing. Artificial water points provided for sheep had allowed euros to occupy areas where they could not have survived otherwise, and in some areas to increase in numbers. It is said by settlers that when leases were first taken up in the nineteenth century, euro density was quite low throughout the area; the former presence of a much larger aboriginal hunting population is the cause usually cited for the comparative rarity of the animals in those earlier days. Large numbers of aborigines, however, were sold to pearl ships or killed, and today only 1,300 full-blooded aborigines are left of the original 5,000 that once resided in the Pilbara district. These are now usually concentrated in permanent camps and do not lead the nomadic life of their forebears. However, the euros in the vicinity of these camps often suffer a much heavier predation from aborigines than they would have when the native population was divided into smaller nomadic tribes. For instance, on Limestone Springs station, in an area of 80,000 acres, 600 natives killed and ate some 10,000 euros in seven years — from 1949 to 1956.

Still another event with an effect upon euro populations was the turn-of-the-century gold rush. Before World War I large numbers of prospectors

Paw-licking serves in lieu of perspiring; the evaporation of saliva acts as cooling process.

Plastic collar is put on euro to identify it and permit observation of individual behavior.

Recaptured pair, *below,* are atypical of species in that they came back to camp for well water.



depended on kangaroos for food. At the height of the 1880-1910 gold rush there were 3,000-odd prospectors in the Tamborah Hills, where now there are probably fewer than a dozen, and about 7,000 persons were then in the Cossack-Roebourne area, which now is worked by a mere 120.

Reviewing this history, it appeared to us that a considerable increase in the euro population, which began before 1930, could possibly be correlated with the decline in the prospecting activity mentioned above. Certainly the euros were present in great numbers during this period, a fact that is apparent in estimates of the number of euros poisoned by sheep farmers. For example, on Bonnie Downs, a station of 359,000 acres, 90,000 euros are reported to have been poisoned between 1930 and 1935.

The dry seasons of 1935-36, which caused a sudden decline in sheep numbers, also resulted in some mortality among euros. There are reliable eyewitness accounts of euros "dying around water holes" on Corrunna Downs, and of a "high mortality" of euros and red kangaroos, but the evidence indicates that these mortalities were related to starvation during drought because the only available plants were low in protein. Either euro density became higher after the big decline in sheep numbers or more notice was thereafter taken of the animals. High densities occurred on most stations until the early forties, no doubt due to favorable seasons. Accounts by local residents indicate that euro numbers again were drastically reduced in the summer of 1944-45.

By 1952, the euros on Woodstock had increased to an average of about one per four acres, but heavy mortality again occurred during the extended dry summer of 1953-54. Euros died by thousands in caves and around dry water holes on Abydos, Woodstock, and far out on the abandoned leases of White Springs and Yandiyarra. Counts at Abydos and at Woodstock showed the density to have been reduced to about one euro per thirty acres.

Today, there are few sheep and many euros. One of the smaller sheep stations at which we carried out some of our research is typical of much of the district. Mt. Edgar station comprises 250,000 acres. Here, there are 4,000 sheep — about one per sixty acres — and, according to our census

WARY OF KANGAROO'S claws and teeth, a member of the Wild Life Survey Section team brings down a euro by the tail. The strong chest muscles and forearms that make it a feared infighter also equip it to dig deep water "soaks."

figures, approximately 30,000 euros — about one per eight acres. The pastures are so degenerated that only low-protein spinifex can be found, and sheep feeding upon this are unable to suckle the few lambs that are born. In contrast, the euros are reproducing so successfully that they can maintain a high density despite the considerable mortality that we have shown to occur periodically among them.

Here was a fascinating problem. We decided to carry out an academic study of the euro and compare our results with what was known about the sheep. We knew the sheep was a ruminant and required about 6.5 per cent (dry weight) of crude protein in its food merely to subsist, and much more to permit successful breeding. Protein analysis of hundreds of plant samples indicated that sheep could rarely find adequate forage for breeding, yet the euro bred and thrived in areas where sheep could not even exist. The euro also has a "ruminant-like" digestion similar to but simpler than the sheep's. Although it does not actually chew its cud, the euro may regurgitate a little food and chew it once or twice a day.

The important part of protein is nitrogen. Herbivorous animals that depend on bacteria to digest the plant fiber for them must obtain an effective quantity of nitrogen per day. Although much is wasted in the urine, sheep are able to retain a small portion and recycle it via the saliva. Our suspicions that the euro could also do this were recently confirmed by a team working in the Department of Zoology of the University of Western Australia. Also, we observed the plants on which the animals grazed, then analyzed the cell structure of mouth, stomach, and feces content. We found that euros eat the same species of plants as sheep; therefore, where euros were dense they actively competed with sheep for the few high-protein plants remaining in these degenerated pastures.

THE reproductive potential of sheep is relatively high. While only one euro in five hundred has twins, sheep frequently do. In addition, sheep have a fairly short gestation period of five months; lambs may be weaned eight months after conception, then wean young themselves within two years of their own conception. The euro is not sexually adult until two years after conception. The gestation period of the euro is only thirty-eight days, but during the eight months in the pouch the young are mainly in a fetal condition.

If the sheep has the potential to produce more young more quickly than the euro, why is the sheep's breeding relatively unsuccessful? We discovered several contributing factors. Under the restrictive conditions of low-protein pastures, the slower growth rate of the euro can be maintained at comparatively less expense in energy on the part of the euro mother, so there is a higher survival rate among the young of the euro than among sheep because of the mother's better condition. Euros also display the phenomenon of delayed implantation, as do some other marsupials and higher mammals. Shortly after the tiny fetus is born and crawls unaided into the pouch, the mother again comes into season and is fertilized. However, the implantation and development of the newly fertilized ovum is delayed until the young already in the pouch has left. Whether it is removed immediately after birth, is lost by misadventure during development, or naturally leaves the pouch after eight months, the quiescent blastocyst does not develop past the two-day stage until the sucking stimulus of the pouch young is reduced or stops. Then, after thirty-six days (not thirty-eight) another young is born.

If the sheep are mated at such a time that the lambs are born *before* the rain has made the grass grow, they die because the ewes cannot produce milk. It is months or, more usually, a year before more lambs are produced. Although many developing euros also die in the pouch from malnutrition during drought another euro is born within a few weeks (in contrast to the sheep) and another ovum is fertilized and stored away. By the time this latter is born, rain may have fallen; if drought still prevails the procedure can be repeated. Only in the more extended droughts, do female euros go into an anoestrous, or non-breeding, condition. Even then many females eventually come back into breeding

Restrained animal's plastic collar is marked in reflector tape visible later to the scientists using binoculars and spotlights in nighttime observations.

condition. Although emaciated by starvation, they produce young *before* the summer rain is due. Young produced at that time have a good chance of survival, because if rain comes the mother will have achieved good health again by the crucial time when the young are five to six months old and require considerable milk. Given adequate summer and winter rains, the breeding pattern is not interrupted.

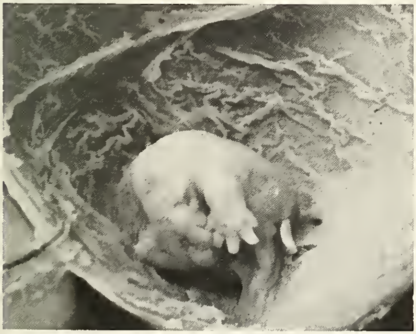
Sheep, we know, are well adapted to the hot, arid climate. Their thick fleece is good insulation against both heat and cold. They can withstand a high body temperature (110°F.) and can regulate that temperature by panting like a dog. Sheep can keep cool far more efficiently than man, and use much less water in the process. If deprived of water, a sheep can tolerate dehydration of up to 25 per cent of its body weight, while, by way of comparison, a man dies if he loses 12 per cent of his weight by dehydration.

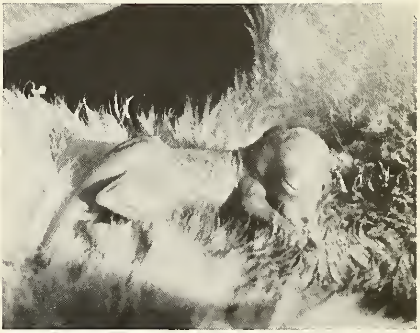
Yet, we suspected that even in the physiological adjustment to dehydration the euro might hold still another decided advantage over sheep. Externally, the euro also has a thick pelage, which acts as an insulation against heat. Another protection is its ability to pant as fast as three hundred respirations a minute when it is very hot. We noted that when the ambient temperature reached 89°F. euros licked their forepaws and hind legs; the evaporation undoubtedly cooled them.

We found out by experiments in our enclosures that euros on a dry diet need water to the equivalent of 5 per cent of their body weight each day in summer. After five days without water they appeared healthy (although they stopped eating) despite a weight loss of 25 per cent. Hundreds of food plants we analyzed contained 30 to 50 per cent water. However, euros that survived more than seventy days without free water but with abundant natural vegetation still lost over 30 per cent body weight when kept in our enclosures. Blood and urine tests conducted for us by the University of Western Australia showed considerable dehydration, while similar tests of animals in the wild showed no dehydration during the same period. This surprised us, and we decided to make further detailed observations of euro drinking behavior.

We knew that kangaroos are able to dig for water, and that they make holes nearly three feet deep in dry, sandy creek beds. Locals call these holes "soaks," and many animals depend on soaks for water. Pigeons, cockatoos, marsupial cats, and even emus probably could not inhabit some regions if kangaroos did not dig down to water for them. We surveyed every creek in the study area, marked each soak, and checked them every month for more than two years.

We also knew exactly what natural water was available to the euros, and





Two-week-old fetus shown above has a gestation period of 38 days. At birth, fetus crawls to mother's pouch to stay 31 weeks. Young in pouch, *above*, is six weeks old . Growth of next fertilized egg begins only when young leaves pouch.

controlled the four wells that had supplied water to sheep in the area before the property had been abandoned. Watering places were fenced, and devices were installed so that each euro was automatically counted and sprayed with brightly colored dye as it came in from the wild and passed through a gate on its way to drink. When soaks dried up in a dry summer we were sure that no euro could obtain a drink without being marked and recorded. Our results showed that many euros were not drinking, although shade temperatures were in excess of 115° F.

To explore this astonishing finding we trapped several hundred euros at the most central well and individually marked each one with a plastic collar bearing a combination of symbols made from reflective tape. At night we mounted a high tower near the central water point, and by using powerful spotlights and 15 x 50 binoculars, we could identify individual animals as far as 300 meters away. We watched continuously for a fortnight at the height of summer in the years 1956 and 1957. Very few animals used more than one well, judging by dye marks. Most marked animals seldom drank, although a few drank as often as once every two days. Nighttime use of spotlights from four-wheel drive vehicles in which we transected the surrounding land gave us information on home ranges of the marked animals: some ranges were only 500 meters wide.

THE interesting fact was that animals whose home range held a heap of granite boulders drank rarely, while those whose home ranges did not include such an outcrop drank more often. Instruments placed in caves in the rocky district indicated that temperatures there never exceeded 90° F. despite ambient shade temperatures of 115° F. outside. Euros do not begin to lick themselves until the ambient temperature exceeds 89° F. Below this temperature, they do not waste water for cooling purposes. Thus their low bodily needs could be met from vege-

tation alone if they remained in the caves during the heat of day.

Although cave-dwelling euros managed without water, why did they do so when abundant water was available at wells? (Our fences did not impede them.) One answer seems to be that of nitrogen utilization. It has recently been discovered by scientists of the East African Agricultural and Forestry Research Organization, in Kenya, that local stock can do well on pastures very low in nitrogen content if the animals' water intake is restricted. Analysis of urine from euros showed that those creatures that had drunk recently excreted considerably more nitrogen than those that had not. Thus, as it is an advantage to retain and reuse this nitrogen rather than to excrete it, it is a distinct advantage for the animals not to drink often. Experiments at the University of Western Australia early in 1963, in which euros were kept on a tightly restricted water ration, have further supported this view.

Nevertheless, hundreds of wells dug by man in the Pilbara insure that during severe drought the euro can have a saving drink. This has allowed the animals to increase in density in some areas and has permitted them to extend even into locations where there are no granite outcrops to provide them with heat refuges. These kangaroos have also moved into regions where there were once thousands of red kangaroos, which dominate pastures that contain high-protein plants. With the degeneration of pastures, the red kangaroos have disappeared and the hardy euro has settled in permanently.

To date, everything the white man has done has made the situation worse for sheep and better for euros. There are approximately two million euros in the Pilbara district. In some areas where regeneration of pastures is being attempted euros pose a problem, and here they will be controlled. Nevertheless, their highly efficient pattern of breeding and their ability to thrive on poor quality food and virtually no water seem to insure their survival.

Mounds of granite boulders, *left*, located on euro's home ranges, afford them insulated daytime cave shelters.

Sheep's rival poses on its field of conquest. Dehydration adaptation and cave shelters have tipped the balance.

SKY REPORTER

Past and present theories on the origin of our solar system

By Simone Daro Gossner

Man's unending quest to understand the workings of the universe were symbolized, perhaps unwittingly, by the anonymous artist who designed the medieval woodcut reproduced at right. Unfortunately, the task of the modern scientist is not as simple as that of the lone traveler shown in the woodcut, who simply lifts the veil of the heavens and peers in awe at the celestial machinery.

The motions of planets were fairly well understood by the beginning of the seventeenth century, when Kepler vindicated Copernicus' views that the sun is the center of motion and showed that planets travel in elliptical orbits. A few decades later, Newton gave Kepler's results a mathematical formulation that—with only minor modifications—has remained valid to the present day.

The problem of the origin and formation of the solar system, on the other hand, has remained unsolved for centuries. There are, to be sure, a number of modern theories that seem to account for observed phenomena, and some of them have gained fairly wide acceptance among scientists. But for the present, they can only be theories, because they deal with events of such an extremely remote past, which occurred during such a long period of time, that they cannot be verified by direct observation.

Early attempts to explain the formation of the sun and its family of planets were inextricably bound to the mythologies and religions of ancient civilizations. It was only in the latter part of the eighteenth century that philosophers and natural scientists began to discuss the cosmic processes by which the solar system might have come into being and might have evolved into its present state.

In a monumental opus of forty-four quarto volumes called *Histoire naturelle*, publication of which extended from 1749 to 1804, the French naturalist George Louis Leclerc, Comte de Buffon, suggested that the planets were created by a comet's collision with the sun. According to his theory, the impact caused expulsion of some solar material that eventually cooled to form planets. We know now that comets are far too tenuous to register a significant impact on the sun, so Buffon's idea remains mostly as a curiosity.

More worthy of note was the theory proposed in 1755 by the German philosopher Immanuel Kant. He supposed that interplanetary space was filled originally with particles capable of moving in a common direction. In regions where the particles were numerous, Kant assumed, they would have formed planets and even the sun itself, under the influence of their mutual gravitation. As will be seen, Kant's views were very close to modern ideas on this subject.

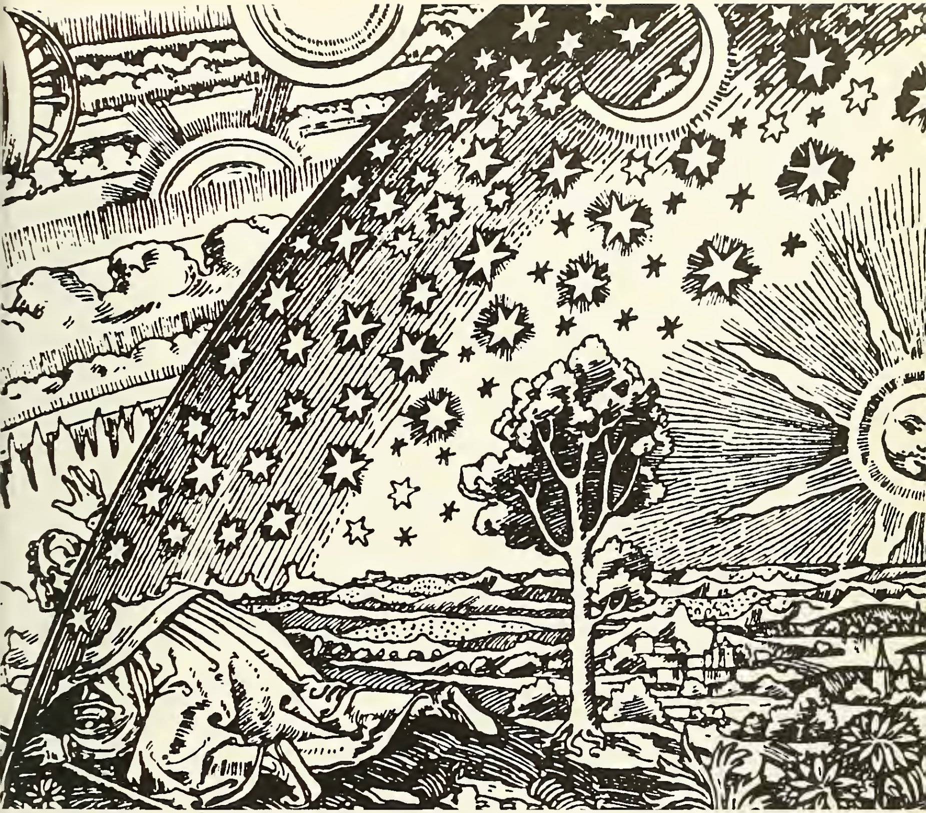
The most famous of all early theories on the birth of the solar system was the "nebular hypothesis" proposed in 1796 by the French mathematician Pierre Simon, Marquis de Laplace. In the appendix of his astronomical treatise, *Exposition du système du monde*, Laplace carefully refuted Buffon's views—with no mention of Kant's—and proceeded to outline his own. As seen through contemporary telescopes, remote galaxies seemed to be starlike condensations in the center of a nebulous ring. Thus misled, Laplace assumed that the nebulae were solar systems taking shape. According to his description, the nebular mass would gradually condense into concentric rings, forming a sun at the center and a planet in each of the rings. This novel theory enjoyed brief popularity, but it led to a number of erroneous conclusions—particularly about the rotation period of planets—and was completely discredited by the end of the nineteenth century.

A number of conflicting theories were proposed in the first few decades of the twentieth century. The most famous of these was the so-called tidal theory originated in 1920 by Sir James Jeans and later expanded by Sir Harold Jeffreys. Its proponents suggested that at some remote date a passing star had raised such a tidal force in the sun that it had drawn from it a cigar-shaped filament of hot gas. As the star continued in its course, the filament remained behind, its far end dissipating into space and its innermost section falling back into the sun. The gases in the central parts of the filament cooled rapidly and condensed into planets. This hypothesis, unfortunately, failed to account for a number of the known features of the solar system and was eventually abandoned.

Current ideas about the formation of the solar system indicate a return to the nebular hypothesis, although Laplace would hardly recognize it in any of its modern forms. Although there is general agreement on broad principles, current theories diverge from each other in matters of detail. The conflict of opinions arises primarily because none of the proposed theories accounts satisfactorily for all the observed data. The greatest difficulty encountered is that all such theories must be guesses in relation to events that are unverifiable in our own solar system. As the American astronomer G. P. Kuiper expressed it: "It is not a foregone conclusion . . . that the problem has a scientific solution. For instance, an enclosure in which the air has been stirred gives, after some delay, no clue on the nature or the time of the stirring. All memory of the event within the system has been lost." In other words, it is not certain that scientists could retrace the development of the solar system, even with all the mathematical methods and modern computers at their disposal.

Kuiper himself has proposed one of the most widely accepted theories of the present era. It is carefully worked out mathematically and involves a highly complex treatment of the subject, much beyond the scope of this article. But in substance, Kuiper assumes that the process whereby

On these pages Mrs. Gossner presents the last in her 1963 series—a co-ordinated review of the solar system.



a solar system similar to ours is formed, resembles in many ways the formation of double and multiple stars.

Stars are believed to form in vast clouds of gas and dust in interstellar space. Depending on the density of the cloud, it may, under certain circumstances, collapse into a flattened pancake shape. As a result of the mutual gravitation of the cloud particles, the "pancake" acquires a fairly rapid movement of rotation and divides into a number of concentric rings, while a sun begins to take shape in the center. Irregularities in the density of the rings lead to the gradual formation of one or more planets in each of the rings.

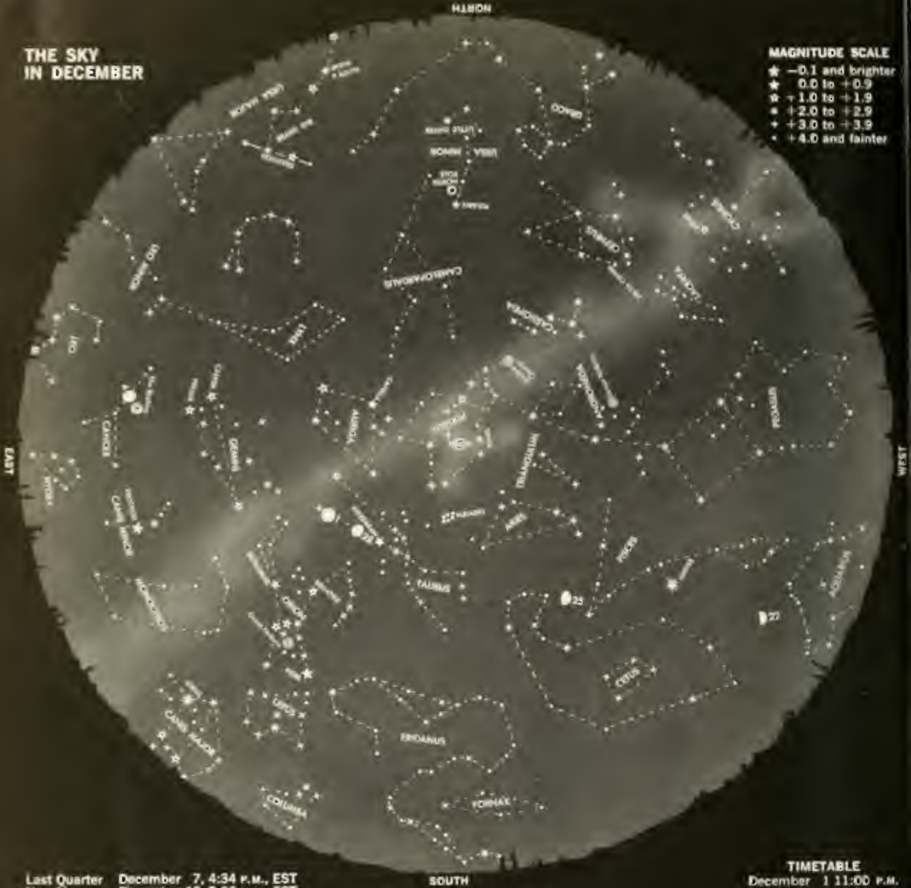
Early in their development, the planets are large globes of mostly gaseous matter, with a small solid core formed by sedimentation. As the sun begins to shine, it gradually evaporates the planets' gaseous envelopes. Thus, planets as seen now would be mainly cores of their ancestors.

Comets and asteroids are believed to develop in rings where the density and distribution of matter are insufficient to sustain the condensation of a major planet. The earth-moon system, on the other hand, presents an unresolved problem. The earth and the moon differ so little in size that they could have been formed in one of two ways: either they condensed as two separate planets within the same ring and eventually captured each other by their mutual gravitation, or else they developed together as one planet with a double core that separated after the evaporation of the gaseous envelope.

THE formation of stars is a continuous process that started at least twelve billion years ago. Some of the oldest stars have already run through their complete life cycle and, in their cataclysmic demise, have returned their material to the interstellar medium. There is observational evidence that our own sun, which is only about five billion years old, is indeed a "second generation" star, born from the debris of older ones. It, too, will some day return its substance to the interstellar voids. Even now, astronomers believe that stars are being born in the spiral arms of the Milky Way Galaxy, and they believe that they may even be observing some of the stars in the process of formation.

THE SKY IN DECEMBER

MAGNITUDE SCALE
★ −0.1 and brighter
★ 0.0 to +0.9
☆ +1.0 to +1.9
• +2.0 to +2.9
+ +3.0 to +3.9
· +4.0 and fainter


NORTH
EAST
WEST
SOUTH
URSA MAJOR
DRACO
URSA MINOR
LITTLE DIPPER
CAMELOPARDALIS
CASSIOPEIA
CEPHEUS
LYNX
LEO
CANCER
HYDRA
CANIS MINOR
GEMINI
AURIGA
PERSEUS
ANDROMEDA
TRIANGULUM
ARIES
PISCES
PEGASUS
AQUARIUS
TAURUS
ORION
MONOCEROS
LEPUS
CANIS MAJOR
COLUMBA
ERIDANUS
FORNAX
CETUS
22
25
27

Last Quarter	December 7, 4:34 P.M., EST
New Moon	December 15, 9:06 P.M., EST
First Quarter	December 23, 2:54 P.M., EST
Full Moon	December 30, 6:04 A.M., EST

TIMETABLE
December 1 11:00 P.M.
December 15 10:00 P.M.
December 31 9:00 P.M.
(Local Standard Time)

All planets that can be seen with the naked eye will be in the evening sky during December. Mercury will reach its greatest eastern elongation December 18, but will be poorly placed for observation throughout the month. It will set one hour after the sun on December 1, ninety minutes after on December 15, and forty-five minutes after on December 31. Its magnitude will fade during the month from −0.5 to +1.5.

Venus (−3.4 magnitude) will be very low in the southwestern sky after sunset. It will set only ninety minutes after the sun on December 1, but its position will improve as the month progresses, and it will set two hours after sunset on December 15, and two and a half hours after on December 31.

Mars (+1.5 magnitude), in Sagittarius, will be very low in the southwestern sky, too close to the sun for viewing. It will set one hour after the sun throughout December.

Jupiter (−2.1 magnitude), in Pisces, will be the best-placed planet for observation. High in the east at dusk, it will cross the meridian in early evening and will set in the west at 2:00 A.M., local standard time, on December 1, 1:15 A.M. on December 15, and 12:30 A.M. on December 31.

Saturn (+1.0 magnitude), in Capricornus, will be low in the south at dusk, setting in the southwest about 10:00 P.M. December 1, 9:15 P.M. December 15, and 8:15 P.M. December 31.

The winter solstice will occur on December 22 at 9:02 A.M., EST, and winter will begin in the Northern Hemisphere.

Two meteor showers may be expected during the month. The Geminids (December 13) have, in past years, attained a maximum rate (for a single observer) of fifty meteors per hour. The Ursids, on December 22, have a less spectacular rate of about fifteen meteors per hour at maximum.

A total eclipse of the moon will take place in the early morning hours of December 30. The moon will enter the earth's shadow at 4:24 A.M., EST, and will be totally eclipsed from 5:27 A.M. to 6:46 A.M. The moon will emerge completely from the shadow at 7:49 A.M. Before entering the earth's shadow and after leaving it, the moon will be immersed in the earth's penumbra for approximately one hour. No sharp shadows will be seen during the penumbral eclipse, which will be marked only by a slight dimming of the moon's brightness. The phenomenon will be visible throughout the United States, except to observers situated on the east coast, where the moon will set while it is still emerging from the shadow of the earth.

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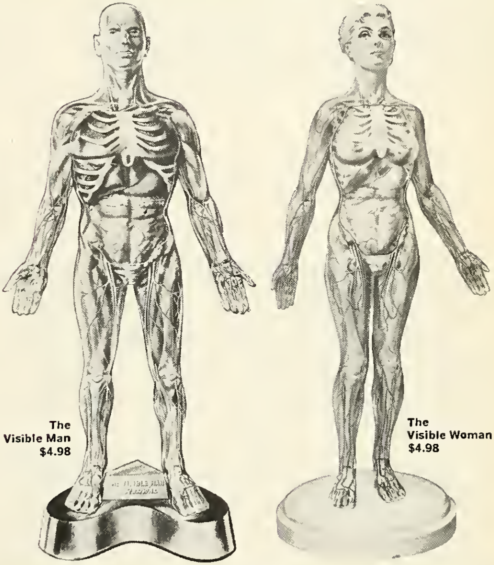

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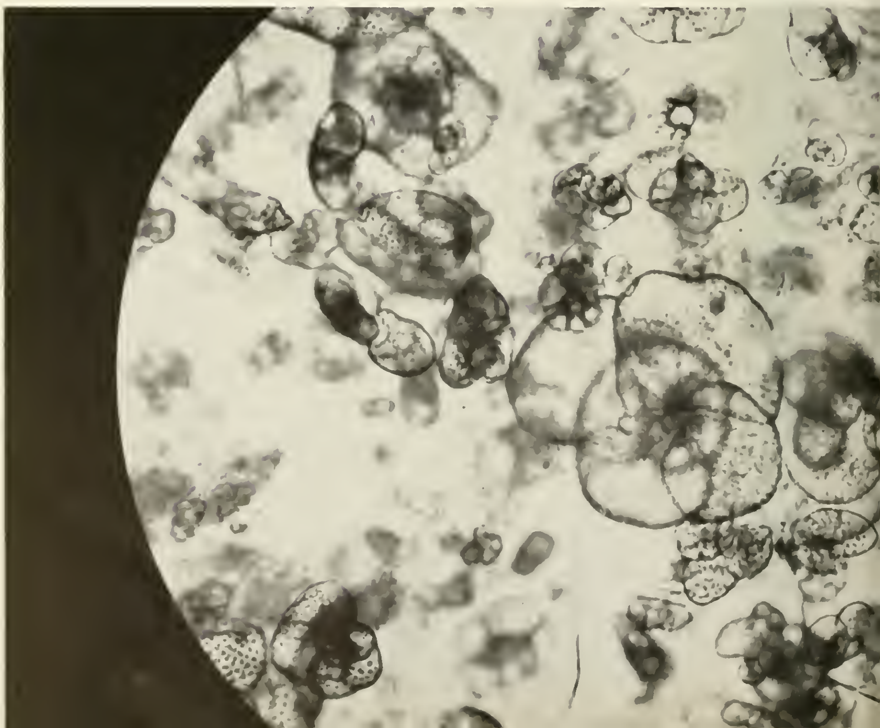
GROSS MORPHOLOGY of one species of foraminifera common to the waters of the eastern coast, *Rosalina floridana* Cushman, is shown 50 times life size. *Below*, animals are enlarged 200 times.

Foraminiferan shells offer clues to sea's resources

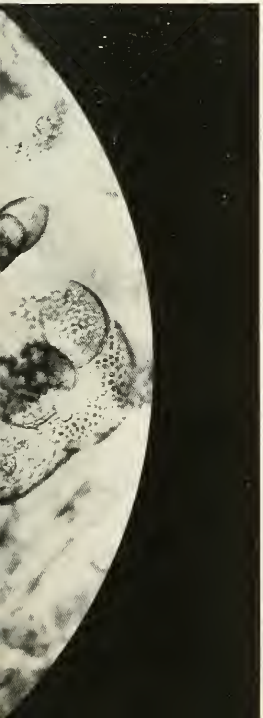
Neglected Amoebas in Culture



By John J. Lee
and Hugo Freudenthal

Only within the last decade or so have we begun to learn about the microorganisms that play such an important part in the marine food chain. New techniques in laboratory culture provide an unprecedented opportunity to study the morphology, life cycles, and nutrition of these hitherto overlooked microorganisms. Large groups of important marine protists (one-celled animals and plants) remain to be studied under the microscope.

Among the marine protists that we have recently learned how to raise in the laboratory are some foraminifera—a group of abundant, shell-bearing protozoa that exist in marine to brackish waters. Paradoxically, they are perhaps better known to geologists and paleontologists than to biologists. The shells of foraminifera may be composed of the organic substance called "tectin," of agglutinated sand grains, or of crystalline calcite. The fossil record left by the calcareous foraminifera is impressive. The great pyramids of Egypt were built of limestone that was formed from compacted remains of countless foraminifera of the species *Nummulites gizehensis*. The white cliffs of Dover are the remains of ancient foraminifera, radiolaria, and diatoms. The latter two are also shell-bearing protists, and therefore left a fossil record. They have a wall containing silica, which, like sand, resists chemical change.



Our knowledge of the ancient past is largely dependent on the discovery of fossils. The abundance and small size of foraminifera in sedimentary rock facilitate the collecting of complete specimens, and at the same time make them excellent diagnostic tools for micropaleontologists. As part of an oil exploration team, the micropaleontologist examines surface samples and drills cores for foraminiferal tests (shells). In each stage of each geologic period different species and assemblages of foraminifera flourished. If the micropaleontologist can identify the species, he can determine the age and sequence of the rock strata he is studying. With such data he is able to plot the stratigraphy of subsurface rocks, and map structures where petroleum may be trapped in porous layers.

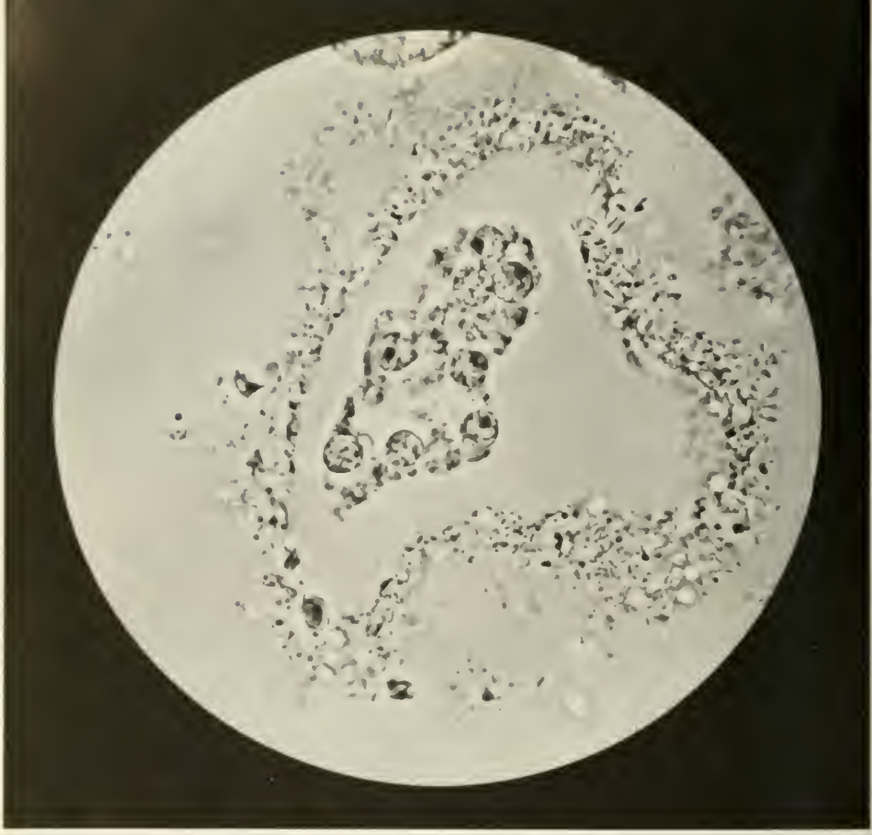
Because of their economic importance in oil exploration, the literature on fossil foraminifera is vast. As an aid to the identification of foraminifera, Dr. Brooks Ellis and Miss Angelina Messina of The American Museum of Natural History have catalogued original descriptions and figures, formations in which each has been found, pertinent references and synonyms for individual genera, subgenera, species, subspecies, and varieties of foraminifera. All told, some 30,000 species of foraminifera have been described, and 26,825 have been catalogued.

Since the turn of the century, however, fewer than a score of scientists have done research on living foraminifera—except for ecological distribution studies. This in itself is hard to understand, since living foraminifera are fascinating creatures. Microscopic observation reveals their strange pseudopodial network—the delicate protoplasmic extensions with which they gather food and move about. This feature separates them from all other Sarcodina (amoeboid protozoans). Through various openings in the test, the protoplasm flows out over the surface and from there, in most species, spreads out in an elaborate network that often extends to from five to twenty times the diameter of the test itself. At high magnifications (X400-X1000), each pseudopodial filament is revealed as an intensely active arterial highway of moving granules, whose composition and purpose are still unknown. Unlike the thicker pseudopods of familiar amoebae, such as *Amoeba proteus*, a pseudopod of a foraminifer seems to be streaming in opposite directions at the same time. The finest pseudopods, which are about 0.5 microns in diameter, contain granules that may even collide as they flow by in opposite directions.

Biologists cannot agree on how these dynamic pseudopods work. One school favors the "fountain zone theory," which places the motive force at the front end of the pseudopod. Another school leans to the "Mast theory," and places the motive force inside the body of the animal at the rear end. Both theories are now being tested in laboratories at U.C.L.A. and at Princeton. Some areas of agreement have already been reached. Most workers feel that the pseudopods of foraminifera are composed of slender internal microfilaments that slide past each other carrying attached granules.

Most foraminifera have a special kind of beauty. The cytoplasm is often richly pigmented blood-red, orange, yellow, or green. The tests vary from simple spheroids to elaborate, multichambered, rectilinear, and coiled shapes. Although most foraminifera build calcareous tests, a number have uncalcified organic or arenaceous tests. The latter are formed by the agglutination of materials from the animal's environment. This agglutination is made possible by secretions to which particles adhere. Some arenaceous foraminifera will cement almost anything on the sea bottom to the test, while others use particular types of sand grains, sponge spicules, or mica flakes. How the organism discriminates between such similar materials is one of the questions to be answered.

As a group, foraminifera are widely distributed throughout the seas, both laterally and bathymetrically. Some species are typically found in salt marshes; others are indigenous to shallow or to deep water; others are planktonic, which is to say they float on or near the surface.

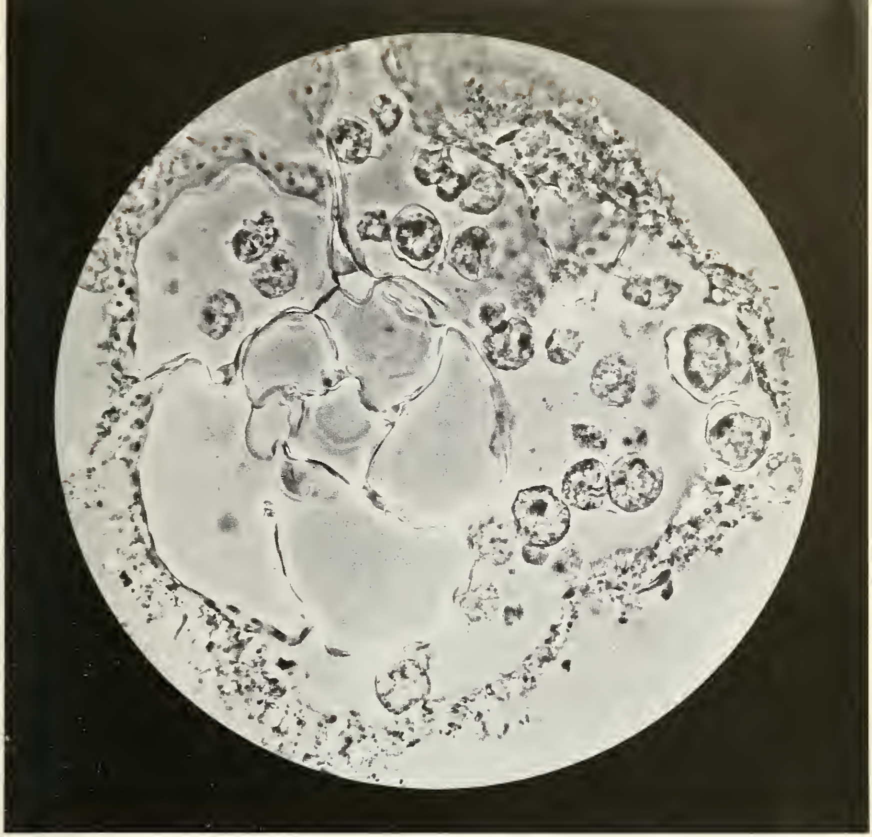


Many foraminifera have seasonal distribution and abundance. Among the most interesting in this respect are the planktonic foraminifera. Recent information, obtained by a group from the Lamont Geological Observatory of Columbia University, has shown that certain species typically live in the cold waters of the Arctic or Antarctic, others in temperate seas, and still others in warm waters. Some species of the temperate seas are most abundant in the winter and spring, when the water is about 18-23 C., while others are most numerous in the summer and fall, when the surface temperatures are about 23-27°C. Preliminary results with deep-collecting devices, including a new pressure-activated plankton net that was developed by Dr. Bé of the Lamont group, indicate that the "winter and spring species" sink to deeper, cooler waters during the summer. The tests of two species, *Globigerina pachyderma* and *Globorotalia truncatulinoides*, change the direction of their coil as the temperature of the water changes. They coil to the right (in a clockwise spiral) in warmer water and in summer, and coil to the left (in a counterclockwise spiral) in colder water and in winter (NATURAL HISTORY, February, 1963).

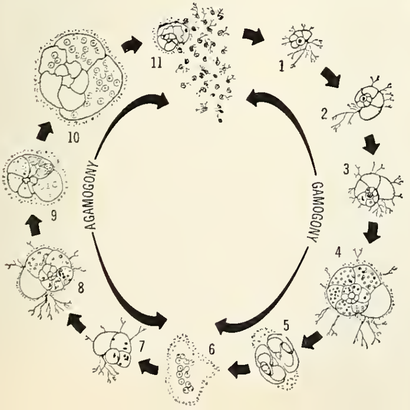
For reasons that are not yet clear, foraminifera are not found uniformly distributed in the environment, even in the seasons when they should be most abundant. Thousands have been discovered in some spots and practically none in nearby areas.

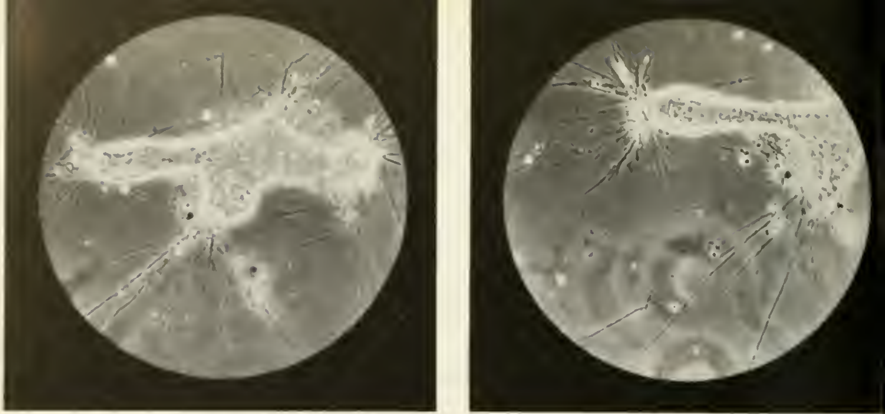
Some of the planktonic foraminifera are floating food factories. Within the test of some species live minuscule, unicellular, symbiotic algae called zooxanthellae, which are probably related to the dinoflagellates. By photosynthesis the algae produce food materials that are used by the foraminifera; the latter provide "housing" for the algal cells, and waste products that act as "fertilizer" for algal growth. If the relationship between the zooxanthellae and the planktonic foraminifera is comparable to other dinoflagellate-host relationships, such as those with corals, it is a profitable one for both organisms. Although either organism is capable of independent existence, each is apparently able to thrive better under the mutually beneficial system that unites them.

Foraminifera trap a wide variety of algae, other protozoa, and bacteria, and on occasion have been observed



Regular cycle of *R. floridana* Cushman, *diagramed below,* is comprised of alternate sexual (1-6) and asexual (7-11) generations. The gamonts (1) of the sexual generation are uninucleate until they undergo mitosis (2-4) and produce internally many gametes. Gamonts pair (5). Their gametes produce zygotes (6), step shown enlarged, *upper left.* After meiosis (8), reproduction by multinucleate agamont (10), *photo above,* produces the gamonts (11) *magnified below.*



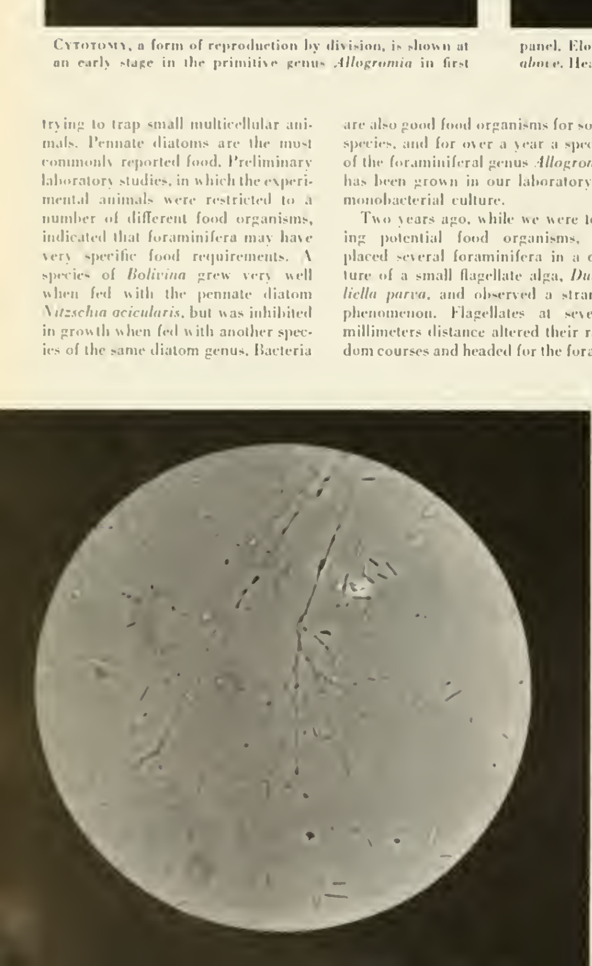


Cytotomy, a form of reproduction by division, is shown at an early stage in the primitive genus *Allogromia* in first panel. Elongation, or "leading head," develops more full *above*. Head pulls away toward the photo's edge in the thi

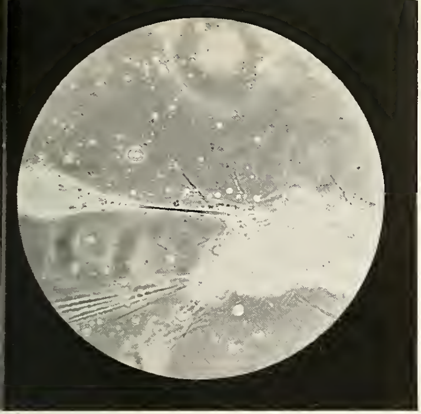
trying to trap small multicellular animals. Pennate diatoms are the most commonly reported food. Preliminary laboratory studies, in which the experimental animals were restricted to a number of different food organisms, indicated that foraminifera may have very specific food requirements. A species of *Bolivina* grew very well when fed with the pennate diatom *Nitzschia acicularis*, but was inhibited in growth when fed with another species of the same diatom genus. Bacteria are also good food organisms for some species, and for over a year a species of the foraminiferal genus *Allogromia* has been grown in our laboratory in monobacterial culture.

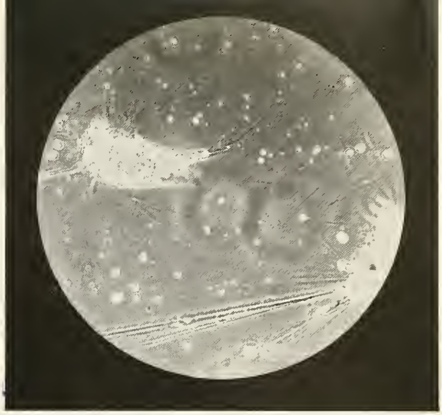
Two years ago, while we were testing potential food organisms, we placed several foraminifera in a culture of a small flagellate alga, *Dunaliella parva*, and observed a strange phenomenon. Flagellates at several millimeters distance altered their random courses and headed for the foraminifera, where they became trapped as food. Further study with other foraminifera in culture leads us to believe that the animals have a fairly general attraction ability. *Dunaliella* shows varied responses to the different species of foraminifera we have tested. Those particular algae are attracted to the pseudopodial nets of *Bolivina* and *Quinqueloculina*; on the other hand, they move directly to the tests of *Milliammina fusca* and *Ammonia beccarii*. Many foraminifera trap and cram as many flagellates as possible into the aperture, or principal opening, of the test, until the outer chambers are green with flagellates being digested in food vacuoles. Others "stockpile" trapped flagellates outside their aperture, and may even surround themselves with flagellates, which appear as green halos around the animal. We have not yet found the mechanism of this phenomenon, which, with tongue in cheek, we have christened the "Circean effect."

Perhaps the most interesting aspects of foraminifera are their life cycles. Until a few years ago we had no idea of their reproductive variations. Most foraminifera that have been studied go through an alternation of generations, from haploid (one set of chromosomes), sexually reproducing individuals called gamonts, to diploid (two sets of chromosomes), asexually reproducing individuals called either agamonts or schizonts. Meiosis, or the



Anastomosing feeding net traps some bacteria in *Allogromia's* environment.





anel. Completion of cytotomy occurs when head separates, *ıst panel*, into a new organism. Note, in second photo, the interconnection of filaments between oral areas. Filaments comprise anastomosing (intercommunicating) feeding net.

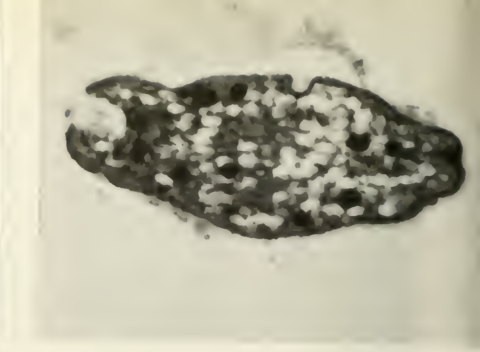
reduction in chromosome number from diploid to haploid, takes place in the asexual generation—this is common in plants but rare in animals.

THE "classical" life cycle of foraminifera was worked out with a beautiful animal, *Elphidium crispum*, which, when it was studied sixty years ago, bloomed in almost pure populations in the English Channel near Plymouth. In this species the gamont and agamont generations are not morphologically identical. The agamont is roughly one and one-half times larger than the gamont. Its initial chamber, the proloculum, is about 10 microns in diameter. In contrast, the initial chamber of the gamonts is about 60 to 100 microns in diameter. Gamonts with this large type of proloculum are called megalospheric; agamonts, with the small type of proloculum, are called microspheric. Gamonts of *Elphidium*, for instance, are uninucleate for most of their lives, while their agamonts are characteristically multinucleate.

In winter collections made in the English Channel, the megalospheric foraminifera outnumber the microspheric by more than thirty to one. From January onward the proportion begins to decrease, until by March and April the ratio may be one to one or less. Schizogony, the multiple asexual division of the agamont that produces gamonts, begins in February and is at its peak by the end of April. Gamonts grow all summer and reach maturity in one year in warmer East Indian seas and in two years in the English Channel. They release flagellated gametes that pair and form a zygote, which secretes the first chamber around itself. By chamber addition and nuclear division this young foraminifer gradually develops into the mature agamont. Another foraminifer, *Patellina corrugata*, which looks superficially like a transparent Chinese coolie hat, has a similar type of life cycle, except that its gametes are amoeboid and creep toward one another to form zygotes.

One of the most notable life cycles is that of *Tretomphalus bulloides*. Here schizogony takes place on coralline algae. The gamonts that are formed gradually migrate to the tip of the alga, where each builds a large final chamber that acts as a float. Floating gamonts somehow find each other, intertwine pseudopods, and release

CIRCEAN EFFECT causes large alga to be trapped by a predator's filaments.



biflagellate gametes that fuse to form zygotes. These sink to the substrate and begin the cycle again.

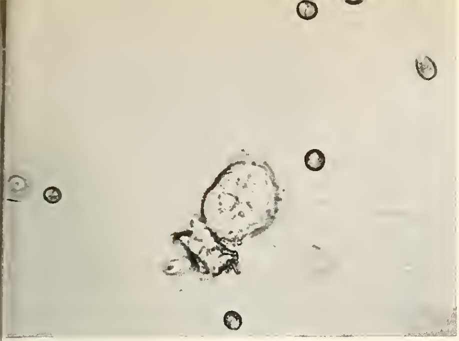
The gamonts of some foraminifera are so unlike their respective agamonts that they have been mistakenly classified as belonging to separate species and sometimes even to different genera! In a recent, as yet unconfirmed, study on *Cibicides lobatulus*, a foraminifer that lives attached to ascidians (sea squirts), a tentative life cycle has been proposed that includes four or more different types of agamonts that resemble no fewer than ten distinctive morphological forms, which, until now, have been classified as separate genera. The different varieties of agamonts develop, apparently, as a result of their position on the ascidian, the texture of the ascidian's tunic, or body wall, the time of the year, and the stage of their life cycle.

Some species of foraminifera have heterokaryotic agamonts. This means that the organisms have two different kinds of nuclei in the same cell—a condition common among the ciliates such as *Paramecium*, which have a variety of combinations of macronuclear and micronuclear types, but which is rare in amoeboid protozoa. Very soon after the zygote in *Rotaliella* spp. is formed it undergoes two nuclear divisions to produce four nuclei. One of these, the vegetative nucleus, enlarges and migrates from the proloculum into one of the newer chambers. The other three—the generative nuclei—remain in the proloculum until schizogony begins. These three form the nuclei of the gamont generation, and the vegetative nucleus eventually degenerates. There is evidence to suggest, however, that the vegetative nucleus is important in the life of the organism. In recent experiments in Tubingen, Germany, an investigator performed microsurgery on vegetative nuclei with a very fine X-ray beam. In such organisms, one of the generative nuclei of *Rotaliella* enlarges and differentiates into a new somatic nucleus, which may control metabolic activities. The life cycles of *Rotaliella* and a few other genera of foraminifera have still another interesting twist: the gamont is autogamous—gametes from the same organism fuse with each other. In *Rotaliella* they do so without even leaving the parent test.

The variable reproductive capacities of *Allogromia*, a simple, primitive genus with two well-known species, are amazing. In addition to being able to produce successive schizogonic generations and sexual reproduction (demonstrated thus far in only one of the two species), they also reproduce by budding and by a special type of division called plasmotomy, in which nuclear division as in schizogony precedes cytoplasmic division. Plasmotomy differs from schizogony in that the former offspring contain more cytoplasm and are produced asynchronously by the parent. Experimentally, when the species we have studied is placed in fresh media it reproduces mainly by binary fission; as the culture ages, the other forms of reproduction become more prominent.

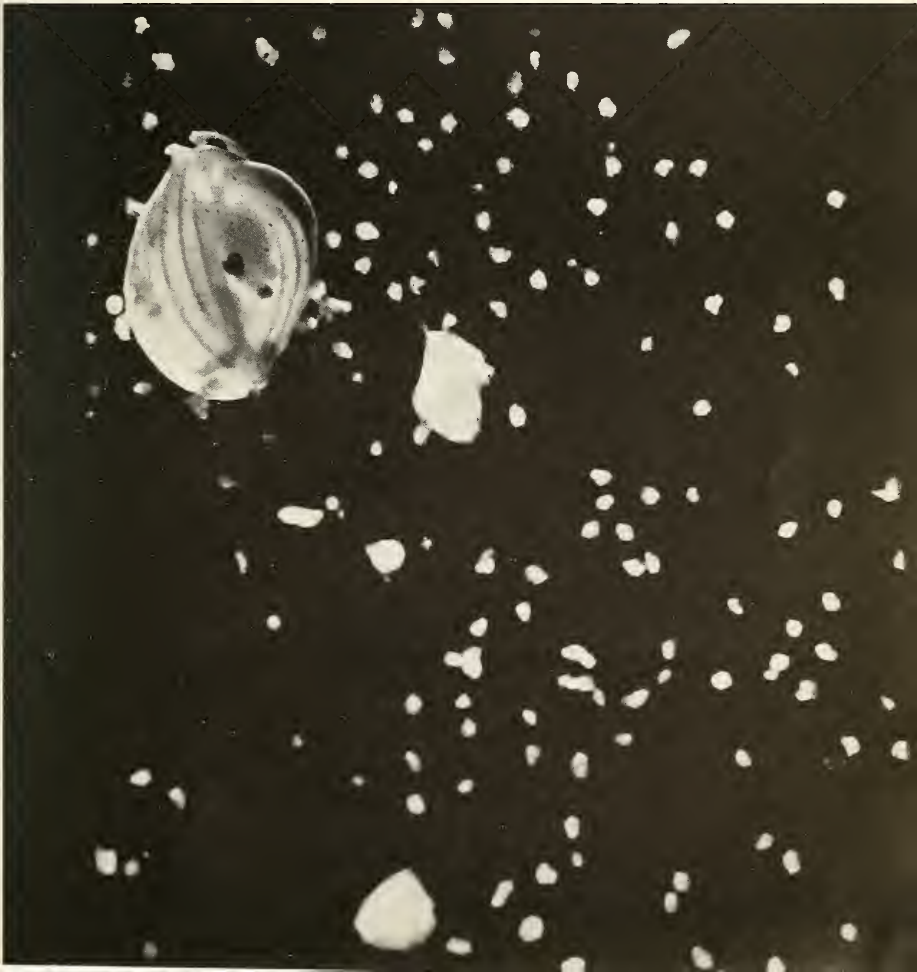
The nutrition, physiology, and histochemistry of foraminifera is an underdeveloped research area. Preliminary cytological work suggests that the animals have some unusual organelles—the "organs" of a unicellular animal. Planktonic foraminifera have a most complicated system of internal banded vesicles, or tubules; its function is unknown. We might speculate that it has a hydrostatic function, but any proof is lacking. Certain arenaceous salt marsh foraminifera, in an experiment with a graded series of salinities as the variable, were found, curiously enough, to reproduce more often and earlier in water with a salinity three or four times the average salinity of the water in which they were collected. To explain this, we have gone back to the field to make more observations. The foraminifera in question had a much narrower distribution than we had previously observed. Most of the animals were collected in a zone between the mean high tide and mean low tide. The life cycle is apparently adapted to their native environment in the intertidal region of the marshes, where the inevitable evaporation of water from the algal mat growing between the roots of the marsh grass leaves a heavy salt deposit. The main clue to a good collecting spot is an area with plants and sediments protected from the violent action of wind, waves, or current. If we are collecting in a marine marsh we usually use a plastic pail to gather some of the filamentous algal mat. We shake and scrub the algae vigorously to separate the foraminifera from the debris, sieve the large particles out, and let the animals settle to the bottom. A hand lens or a dissecting microscope is indispensable in the field for ascertaining what has been found. If care is taken in the separation process, crude cultures of some foraminifera, given a moderate amount of light and protected from excessive heat and evaporation, can be established.

We have just begun to study and understand foraminifera. These and other animals, including the radiolaria, acantharia, silicoflagellates, tintinnids, coccolithophorids, and other poorly known, strangely named microorganisms must be understood if the resources of the seas are ever to contribute to the growing needs of mankind.



Primitive and generalized, the genus *Allogromia* is capable of schizogonic and of sexual reproduction, as well as cytotomy. It also forms the internal and the external buds shown in animal, *far left*. Two-mouthed, multinucleate form appears, *center*. Monoral protist attracts *Dunaliella* prey, *right*, by the Circean effect.

Dispersal of the myriad new schizonts is a climactic moment in cycle of five-chambered *Quinqueloculina*, *below left*. Two large masses are unassimilated food.



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About the Authors

Professor George M. A. Hanfmann, of the Fogg Art Museum of Harvard University, was field director of the Sardis excavations of 1961, a joint venture of his museum and Cornell University that was executed with the aid of a grant from the Bollingen Foundation. Twenty-two American and seven Turkish investigators took part in the mammoth excavations of which Dr. Hanfmann writes in "Digs Expose Ancient Lydian Capital." Other sponsors of the digs were the American Schools of Oriental Research, the Department of State, and the Corning Museum of Glass.

This issue's cover story is written by Mr. Karl Kup, adviser to the Spencer Collection of The New York Public Library, Curator of the Library's Prints Division, and Chief of its Art Division. Mr. Kup was born in Holland but has made his home in America for some thirty years. The author taught at Columbia University and Pratt Institute in New York, and has been a guest lecturer at many universities, including the University of California. His chief interest is the history of the illustrated book.

In "Kangaroo Cave Life," Dr. E. H. M. Ealey, a Senior Lecturer in the Department of Zoology and Comparative Physiology at Monash University in Melbourne, Australia, describes lengthy field work with a species of kangaroo. The research was conducted by a team of scientists, among them the author, under the aegis of the Wild Life Survey Section of the Commonwealth Scientific and Industrial Research Organization. Dr. Ealey recently toured the United States showing a motion picture made at the site of the project. The photographs reproduced with the article were also taken by the author during the course of the investigations.

Dr. John J. Lee and Dr. Hugo D. Freudenthal operate the Living Foraminifera Laboratory in the Department of Micropaleontology at The American Museum of Natural History. In "Neglected Amoebas in Culture," the authors set down the findings of their recent research into the life cycles of some lesser known microscopic animals whose cousins have been of vital import to the petroleum industry and whose fossil remains are caked in the chalk cliffs of Dover. Dr. Freudenthal is also Associate Professor of Biology at C. W. Post College of Long Island University.

Paul Mason Tilden is a writer and editor with his base in the nation's capital. In "Washington Newsletter," Mr. Tilden regularly contributes observations of capital activity that may bear upon the related worlds of science and nature.

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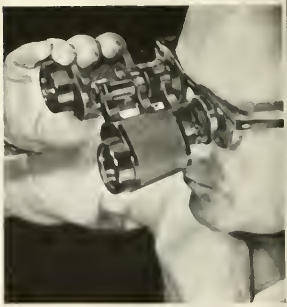

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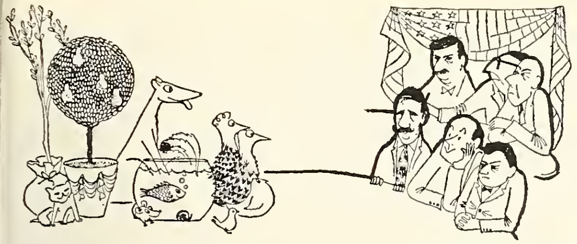

WASHINGTON NEWSLETTER

By Paul Mason Tilden

Conservationist groups are often criticized by the press and in legislative halls for unreasonable idealism and a disinclination to compromise. There have been numerous instances in which such criticism has been merited.

Most conservationists, however, are possessed of a strong streak of practicality, submerged though it may be on occasion, and are as aware of modern life's necessary demands upon resources as anybody else. Conservationists do not have to be lectured that trees must be cut to build their houses, nor that coal and iron must be mined to furnish them with automobiles. They are certainly aware that, in the present state of technology, a wormless and unblemished apple means the use of pesticides.

Perhaps a major part of the conservationist's job is to help lay out guidelines for the production of life's essentials with a minimum disfiguration to the natural scene and a minimum interference with the processes of nature.

In respect to the first of these two broad aims there has been considerable recent conservation activity on a front that has for a long time groaned for corrective measures.

Strip mining of coal (often but incorrectly called a mineral) is practiced in localities where a seam or seams of the fossil fuel are close enough to the earth's surface to allow either direct recovery by power shovel, or the removal of soil and rock overburden and then stripping of the coal by mechanized shovel. In either case the effect on the landscape is hardly less devastating than that of a low-level nuclear explosion. This is especially true where the "dip" of the coal seam (the angle it makes with the horizontal) is either nil or very low and the seam is extensive, allowing stripping to proceed unchecked over a wide area.

Not only is the ecology of the immediate terrain drastically altered—if sufficient plant and animal life remains to warrant the use of the term "ecology"—but also, especially in mountainous districts, halos of further and more subtle damage surround the stripping operation. Raw earth of spoil banks slumps and slides down mountainsides with winter rains and spring thaws. Silt chokes the drainage of the surrounding terrain. Sulphur, largely in the form of metallic sulphides, is a common contaminant of coal, and the steady release of sulphuric acid, created through chemical reaction between the sulphides and water, leaves creeks and rivers veritable biological wastelands, devoid of aquatic vegetation and animal life.

It is becoming obvious that the nation can no longer afford such gross abuses of its lands and waters, and coal strip mining, as presently practiced, has come under Congressional scrutiny during the past session of Congress. Several pieces of legislation have been proposed. Most important of these would probably be House and Senate bills, identical in language, providing for a study by the Secretary of the Interior of *all* strip and surface mining operations in the United States, whether for coal or minerals. The bills would provide for inquiries into the nature and extent of strip mining operations in the nation; hazards to public health; effect on the natural scenery; effect on the fish and wildlife and other natural resources of the United States. Another bill would forbid strip mining of coal on national forest lands. Even coal mines of conventional sorts—drift type and shaft type mines—came in for attention. Thus, bills were introduced into the House to amend the Federal Water Pollution Control Act to provide for the sealing of abandoned mines to prevent pollution of waterways through runoff of acid-charged waters.

The Commonwealth of Pennsylvania, parts of which have long agonized under the impact of uncontrolled coal stripping, has chosen not to wait for the wheels of Congress to grind out corrective national legislation. During the past summer its Governor signed a tough strip mine control bill that, in one form or another, has been brewing for the past twenty years. Under the ceaseless prod-

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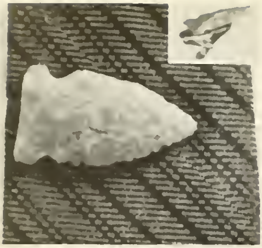

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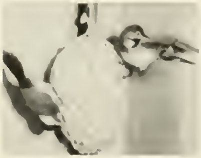

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ding of conservationists—and also o sportsmen, who have a direct and obvious interest in the matter—the Pennsylvania Legislature passed a bill that will be eyed in other states as a possible prototype for statutory control.

Henceforth, coal strippers in Pennsylvania will be licensed by the state. Companies will file detailed plans of their operations with a new five-man Land Reclamation Board, and they will restore the land to its original contour after coal is recovered. In mountainous terrain, where contour restoration would be obviously impossible, the new board may approve terrace backfilling, with angle of slope of the backfill not to exceed forty-five degrees. Operators will be responsible for prevention of stream pollution by acid or silt, under penalty of heavy fine or imprisonment, and continued or flagrant disregard for the provisions of the new act will lead to revocation of operating licenses.

California Atom Controversy

WHILE Congress was taking under advisement possible legislation affecting energy-producing coal, a West Coast conservation battle continued to rage over another kind of energy-producing material—uranium fuel.

Specifically, it concerned the location of a proposed public utilities company's 325-thousand-kilowatt boiling-water nuclear reactor near the tip of Bodega Head in Sonoma County, some fifty miles north of San Francisco. Bodega Head, a granitic peninsula about two miles long and a half-mile wide, juts south from the California mainland just north of the newly created Point Reyes National Seashore in Marin County, and is separated from Point Reyes by Bodega Bay.

The Head itself has been recommended at one time or another for parkland acquisition at the state level—indeed, in 1956, the California State Legislature appropriated $350,000 to add Bodega Head to existing Sonoma Coast State Park land to prevent its future use for residential development. It is an isolated and gemlike peninsula, adjacent waters of which teem with all manner of marine life—one of the "significant biologic areas on the Pacific coast," according to National Park Service researchers. Prior to the nuclear reactor invasion, the Head had been viewed by the University of California as an admirable site for a marine biological laboratory.

The people of Sonoma County have been notably unenthusiastic about the prospect of playing bedfellow to 75 tons of 2½ per cent enriched uranium fuel—equivalent to about 375 pounds of pure uranium. Nor are they encouraged to know that the great San Andreas Fault, which has been active since at least early Tertiary time, passes within 1,000 feet of the proposed atomic power plant. It was this fault, with a total length of more than 650 miles, that destroyed San Francisco in April, 1906. Its two opposing fault blocks, which move horizontally, still slide along each other at a rate of approximately half an inch per year in the vicinity of Bodega; the total slip along the San Andreas Fault in the great earthquake of 1906 was from five to ten feet at this locality.

In spite of the efforts of conservationists at both local and national levels, the California Public Utilities Commission has given the green light to construction of the power plant at Bodega Head. California conservationists, in particular, have been vociferous against the plant and have banded together under the formidable title of the Northern California Association to Preserve Bodega Head and Harbor. As this was written, the Association was contemplating an appeal to the California State Supreme Court in regard to the CPUC's decision, which was, incidentally, not unanimous. Dissenting, Commissioner W. M. Bennett commented: "Obviously there is a highest and best use of land. A myopic business judgment has missed it here." The Commissioner's views coincided closely with those of the conservationists—the isolation and beauty of Bodega Head, and its proximity to state and federal parklands should rule out the location there of a nuclear power generator and its associated machinery.

Right Hand and Left

CONSERVATIONISTS, and especially those who are bird enthusiasts, are deeply disturbed about a Department of the Interior policy that goes to great lengths to protect certain endangered species of birds, and at the same time sanctions the shooting of others. In the protected category might be cited the whooping crane, with its Aransas Refuge on the coast of Texas; the huge trumpeter swan, with its Red Rock Lakes Refuge in Montana; Kirtland's warbler (of which there may be a thousand remaining individuals) and its recently established Kirtland's Warbler Management Area in the Huron National Forest of Michigan's Lower Peninsula.

In the unprotected group might be listed the whistling swan, a bird whose total numbers have hovered around the 100,000 mark during the past eight years, and whose future can certainly be called highly questionable because of the possibility of mass disaster in nesting or migration. Nonetheless, an open season on the whistling swan was held in Utah last year, in the course of which 313 of the big birds were killed and

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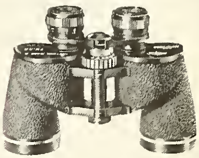

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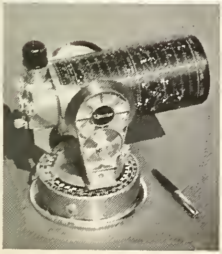

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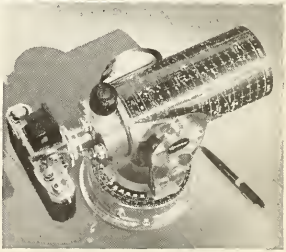

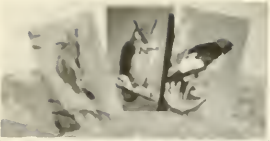

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another 82 crippled. Unless there is a radical change in policy before this column sees print, another open season on the bird will have been held in the same state killing hundreds more.

It has been suggested that there was a connection between the open season on whistling swans and the apparent reduction in numbers of the remaining few whooping cranes during their 1962 southward migration. Open seasons on the sandhill crane, which also can reasonably be considered an endangered bird, have been authorized in certain southwestern states since 1960 on the grounds of crop damages.

In answer to the urgent protest of one conservation organization, Assistant Secretary of the Interior Frank Briggs wrote in the best tradition of Washington officialese "Please be assured of our intention to manage migratory birds so as to maintain them in perpetuity and provide everyone an opportunity to enjoy this resource to the fullest." Replies of this nature are sometimes known in Washington conservation circles as Standard Governmental Response "A." Bird enthusiasts were confused.

Building the Bigger Dam

If ours is the age of the atom, it is also the era of the bigger dam. The recently proposed Rampart Dam on the Yukon River in Alaska, about 90 miles northwest of Fairbanks, will be a 525-foot-high structure that will impound a body of water some 10 per cent larger than Lake Erie. Proponents of the huge impoundment, which would be constructed by the U.S. Army Corps of Engineers, point to the immense source for hydroelectric power that will be available at Rampart. No one has specified how this vast volume of power might be used in the present state of Alaska's development. The possibilities of flood control for the Yukon River are also cited, although the urgent need for this has yet to be convincingly demonstrated. An enthusiastic Congressional supporter of the Rampart Project has urged the dam's construction on the grounds that it would be larger than anything the Russians have ever built.

Against a background of such misty motives a number of national conservation organizations have strenuously protested the suggested inundation of some 11,000 square miles of interior Alaska, 8,000 of which are valued as prime waterfowl producing habitat. One such organization has characterized the Rampart Canyon Power Project as "an extravagant plan that appears to make little if any provision for the invaluable natural and scenic resources that would be . . . destroyed by drawdowns."

When the project first began to simmer, the Fish and Wildlife Service requested nine years and a million dollars to assess the biological wealth that might be wiped out. The request was scaled down to a bare minimum, so that little has actually been learned about the biota of the terrain that would be flooded. No plans have been made for prevention of fish losses on the Yukon. (Fish runs past the dam site numbered 22,000 king salmon and 114,000 chum salmon in 1961; no count has been available to indicate the vast horde of coho salmon that also pass upriver at this point.) It has been estimated that the area to be inundated produces 1.5 million ducks, geese, and cranes every year, and that there would be an immense, and as yet unassessed loss of moose, caribou, fur-bearing mammals, and small game. Mineral, timber, and oil and gas studies have never been included in any evaluation program of the area.

The whole concept of "the big dam," with its concomitant hydropower, water supply, flood control, and so on, is beginning to appear archaic, as well as too destructive of natural resources, many conservationists believe. Big-dam philosophy is in need of re-examination, preferably by the scientist and the conservationist, certainly not by the politician or the professional engineer alone. For the present, however, the emphasis is certain to remain on bigger and bigger and bigger dams.

One More Look at Poisons

For several years prior to 1963 there had been strong pressure on the National Park Service and the Department of the Interior to open the national parks and nature monuments to public hunting. The pressure, generated by certain state game department officials and some sportsmen's groups, had been exerted under the rather thin pretext of assistance to the Park Service in controlling certain ungulate mammals whose numbers in some areas were greater than the carrying capacity of their ranges. Among such troubled areas were Yellowstone, Rocky Mountain, and Grand Teton National Parks, with considerable excesses of elk; Acadia and Sequoia Parks, with modest excesses of deer; Zion National Park in Utah and Dinosaur National Monument in Colorado and Utah, with overabundant mule deer populations. The Park Service and conservationists in general had contended that the problem was one that could, and should, be solved by Park Service personnel without public "assistance."

As a result of the pressure for public hunting in the parks, a commission was appointed in 1962 by the Secretary of the Interior to study the entire question of wildlife management in the national parks and monuments. Its report to the Secretary, delivered in April of this year and reported in this column (NATURAL HISTORY, June-July, 1963), effectively silenced—at least for the present—all commotion over the matter. Essentially, the report of the commission, headed by Dr. A. Starker Leopold of the University of California, reaffirmed the position of the National Park Service that public hunting in the parks and monuments was neither necessary nor desirable. The report was eloquent in the simplicity and forthrightness of its language; anything less would, under the circumstances, have brought forth a storm of criticism from conservationists, hunters, and game commissioners.

Having issued the report, Dr. Leopold's committeemen might well have taken long breaths and returned to their professional pursuits. But during the summer another potentially explosive conservation issue was handed to the commission by Secretary of the Interior Stewart L. Udall.

The subject to be investigated is the government's role in the control of rodents and predators, an activity that has been carried on by the Branch of Predator and Rodent Control in the Department of the Interior. The job is one that in times past has provoked criticism on grounds both aesthetic and ecological.

Predator and rodent control means, in plain language, the shooting, trapping, or poisoning of various animals considered detrimental to the interests of farmers and ranchers: the mountain lion, the coyote, the prairie dog, certain birds, rats, mice, and other creatures. Into the control program go nearly $2 million a year in federal money, and $3.5 million in state and local funds.

The use of poison, especially, has come under strong critical fire from preservationists and conservationists, and from offended laymen; powerful poisons have not, on occasion, stopped with dead predators or rodents, but have passed along the links of the biological chain to strike again far from their original targets. It has often been claimed that predator and rodent control is leading to drastic reduction or even extermination of some species of desirable animals. Such effects, in the long run, merely compound the problems of the farmer and rancher. For example, the wholesale slaughter of the coyote often leads to an explosion in the rabbit and mouse populations. If the poisoners concentrate on the rabbits and mice, they are likely also to kill eagles, hawks, owls, and foxes, not to mention an occasional domestic pet.

Is the government doing too much of this kind of work or not enough? Are certain desirable species of animals really being threatened with extermination? These and several other related questions will be canvassed by Dr. Leopold's hardy commission. Its answer, as was its report on wildlife management in the parks, will very likely become a "best seller" in the conservation world.

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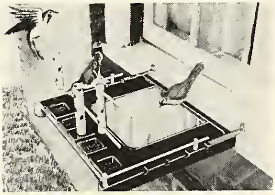

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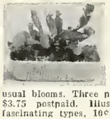

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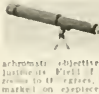

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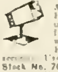

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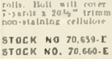

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